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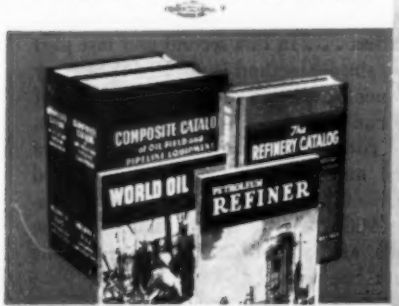

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A Quick Look at

Petroleum REFINER

this month

Is U. S. Oil Industry Being Drowned by Excessive Imports? . . . No! says a major company economist. Yes! declares the IPAA president. Turn to **pages 76-77** for presentation of both sides of a problem that has made of the industry a house divided against itself.

Desulfurization Symposium . . . This neatly-packaged 12-page report to PETROLEUM REFINER readers takes up a major problem facing the industry. Running in the octane race, refiners are taking a close look at every scheme which will make the fuel needed for high-compression ratio engines. Up for top consideration are the desulfurization processes which increase lead susceptibility and in turn the octane number of gasoline. In this symposium you will find the economics and importance of desulfurization together with detailed descriptions of nine popular processes. **Page 81.**

An Auxiliary to Petrochemical Processing—Tonnage Oxygen . . . This is a three-part series covering all phases of this increasingly important subject. The use of tonnage oxygen to replace air in oxidation processes is being studied more and more by petrochemical manufacturers. Part I is concerned primarily with the principles of rectification and refrigeration as applied to oxygen manufacture. It is all done in Peter Sherwood's easy-to-read style. See **page 93.**

Applying Henry's Law to Concentrated Gas-Solvent Systems . . . For many gas-solvent systems, the usefulness and applicability of the Henry's Law expression may be greatly extended by relating the component partial pressure in the gas phase to the mol ratio of that component in solution. The corresponding mathematical relations for the equilibruim y/x value are developed, and a method of plotting is suggested. The significance of the equations in chemical engineering practice is demonstrated by several examples. **Page 97.**

The Reactions of the Olefins . . . Continuing the series, "Understanding the Chemistry of Petrochemical Reactions," the author discusses the various reactions of the olefins which are of industrial importance today. Sulfation, hydrohalogenation, oxidation, and polymerization are but a portion of the reactions explained. If you do not have a good understanding of these basic reactions, turn to **page 101.**

Simplified Design for Viscous Oil Heat Exchangers . . . Here are simple methods for designing shell and tube heat exchangers in the viscous region. Did you know that the inside film coefficient based on the inside tube diameter is independent of the inside tube diameter? This makes for simpler heat transfer calculations. Also, it is not necessary to calculate the bare tube temperature if you take advantage of an ingenious mathematical device which circumvents the complexity of a rigorous treatment. And it is all done for you in this paper. All you do is use the simplified final relations. **Page 105.**

Horizontal Versus Vertical Pumps . . . New light is shed on a controversial subject with this top flight engineer's practical analysis of the advantages and shortcomings of each of the two types of pumps. His conclusions: use horizontals when floor area, corrosion, and maintenance are the critical factors. Use vertical pumps if NPSH, priming, headroom, or flexibility are dictating the choice. For the reasons back of these deductions, turn to **page 111.**

A direct method for predicting Vapor-Liquid Equilibrium Ratios . . . In this second and last part of this paper this simple method is applied to ternary and multicomponent systems. This is a method of eliminating trial-end-error calculations for these data. An easy way to compute the convergence pressures is included. The authors compare their calculated data with experimental data for convergence pressures as high as 9000 psia. In these calculations the calculated results are all within 6 percent of the experimental data. See **page 115.**

Take Another Look at Gas Turbines . . . Economical maintenance and low operating costs have been experienced in the use of gas turbine compressors by four companies. El Paso Natural Gas Company, Oklahoma Gas and Electric Company, Atlantic Seaboard Corporation and Mississippi River Fuel Corporation have had varying amounts of experience with the units. How are they doing? See **page 120.**

New Design Features of Houdriflow . . . Recent highly interesting (and novel) developments in the mechanical design of Houdriflow catalytic crackers warrant this very informative paper. The two well-qualified authors take an engineer's-eye view of the design improvements in the reactor vapor disengager, kiln air distributor, kiln cooling units, and kiln withdrawal sections. Profusely illustrated and clearly written, this article is important reading for all process and design engineers and cat cracker operators. **Page 121.**

New Fluid Coking Process Unveiled . . . Esso's solution to the fuel oil problem is described by two of their top engineers. The new process employs the highly successful fluidized-solids technique for the production of an unusually high quality coke. For all pertinent operating data, yields and product inspections, and important design data, turn to **page 127.**

A Performance Report—The Lummus Continuous Contact Coking Process . . . The first installation of the new Lummus Coking process has been completed and tested at Shamrock Oil & Gas Company's Sunray refinery. The performance tests demonstrated these outstanding advantages: continuous rather than batch operation, higher octane gasoline, and higher yield of olefins. For all the facts and figures, concisely told, turn to **page 131.**

Medical Research Promotes Safety . . . Research directed toward finding if new materials, products and processes could produce harmful physiological effects is bringing a new team of specialists into the field of safety. Medical doctors, industrial hygiene engineers, biologists, chemists and toxicologists are combining their efforts in the Medical Research Division of Standard Oil Development Company. For what they are achieving and hope to achieve, see **page 207.**

The Courts Say . . . Have you noticed this new department? In this issue you will find the fourth of this series which will interest every reader and is aimed straight at the pocketbook of every employer. Authored by a Dallas attorney, "The Courts Say . . ." strips actual compensation cases of legal gobbledegook and hands them to you in simple, absorbing style. You will find out this month that traumatic neurosis is compensable, that an employer is presumed to know "injury" includes aggravation, and that an injury may itself be an accident. See **page 210.**

Maintenance Issue

IN JANUARY

Thirty-two profit-packed pages summarizing the maintenance wisdom and knowhow of carefully chosen experts from all over the U. S. will be yours for the reading in the January issue. Beamed at the manager, the foreman, the engineer, and the man in the field, this issue is the highlight of REFINER's coverage of the vital field of Maintenance. Included in the table of contents are:

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- **How to Run an Inspection Department**
- **Maintenance of Gas Engine Driven Compressors**
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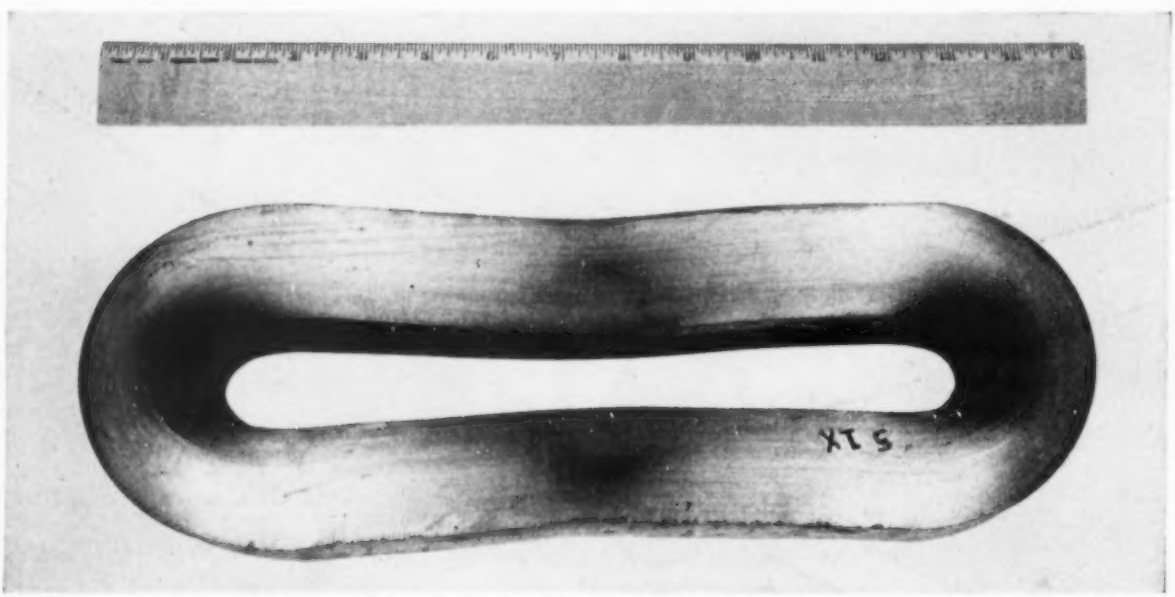

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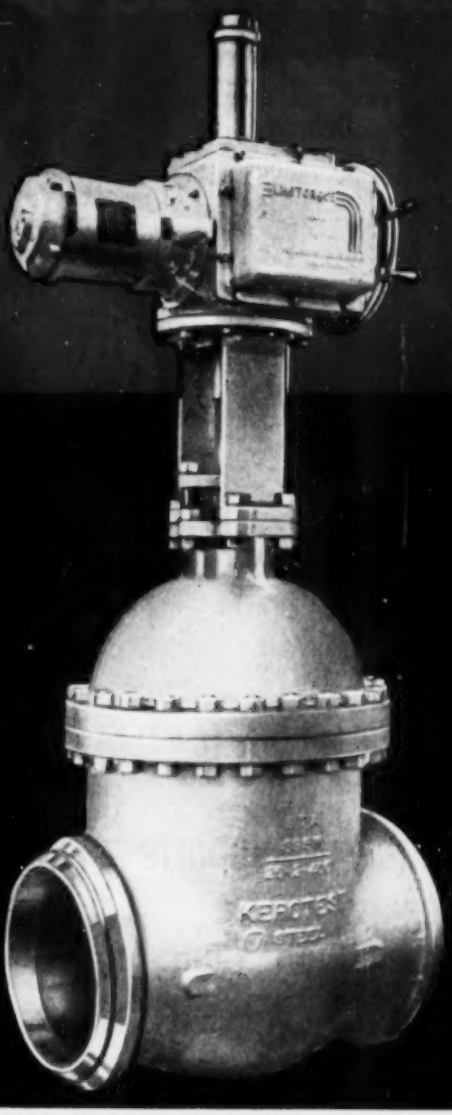

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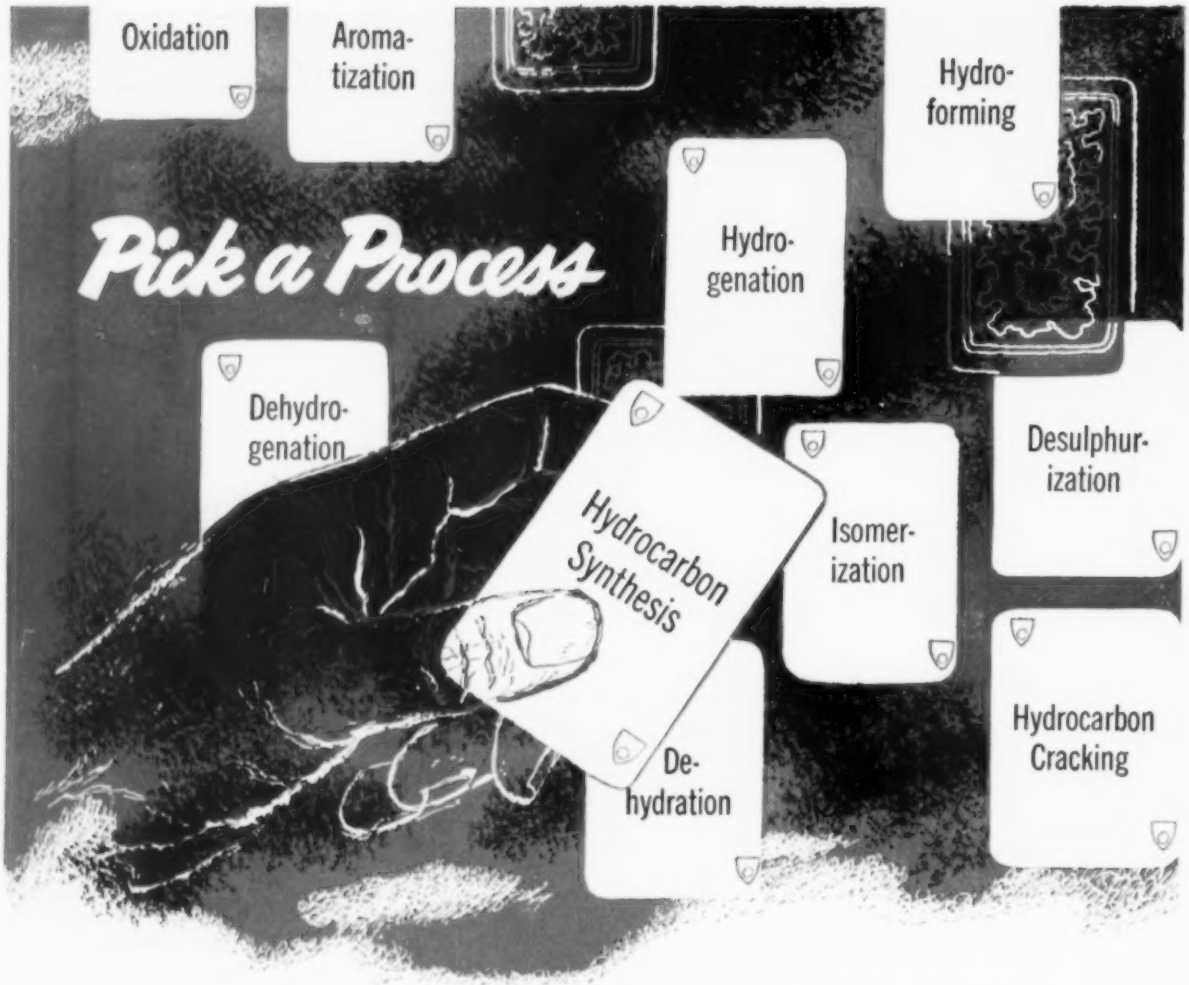

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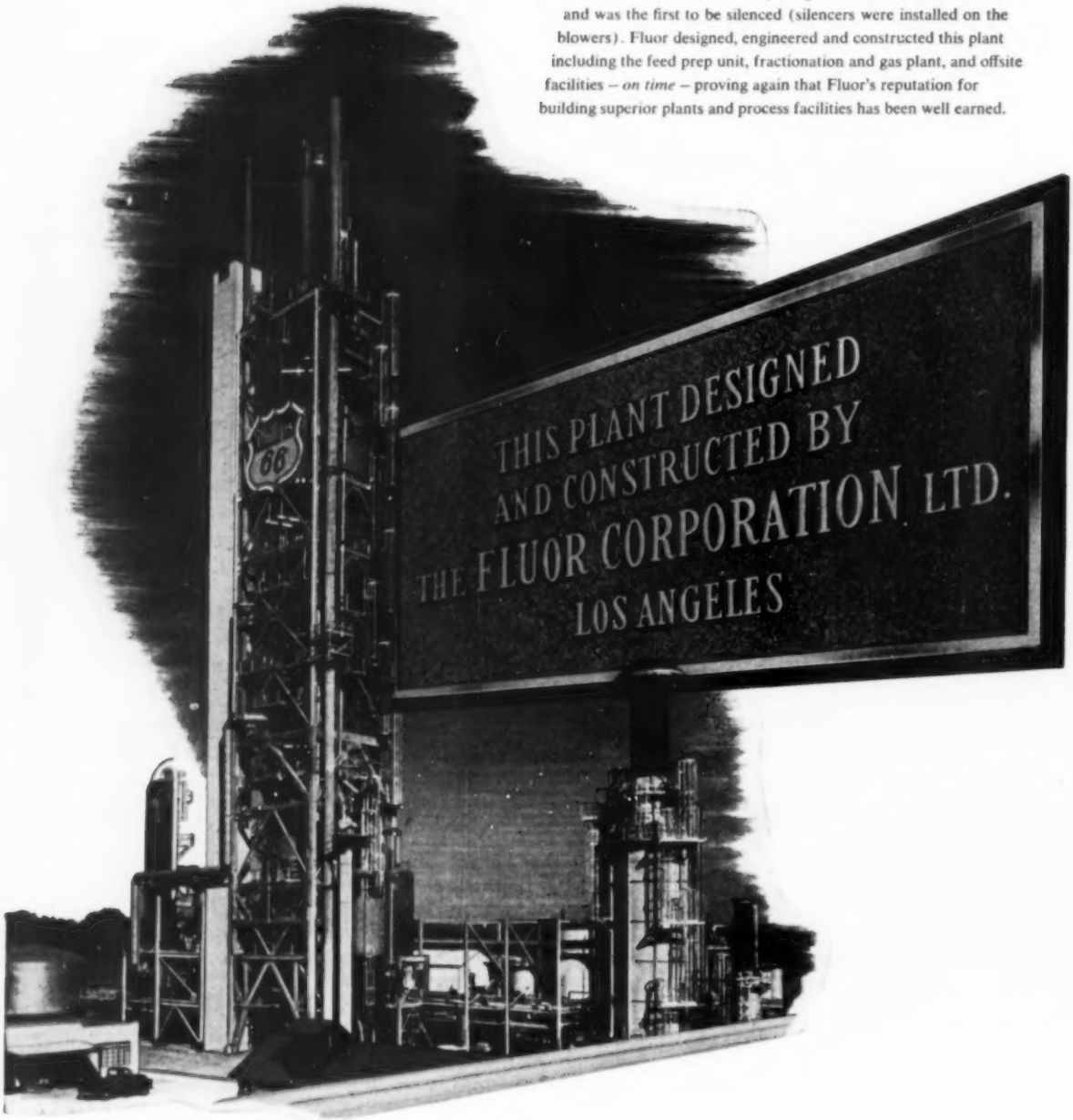

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☐ Oil-Lubricated, Frame-type Pumps	52B7638

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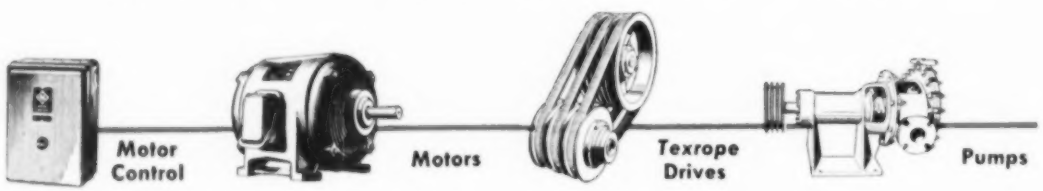

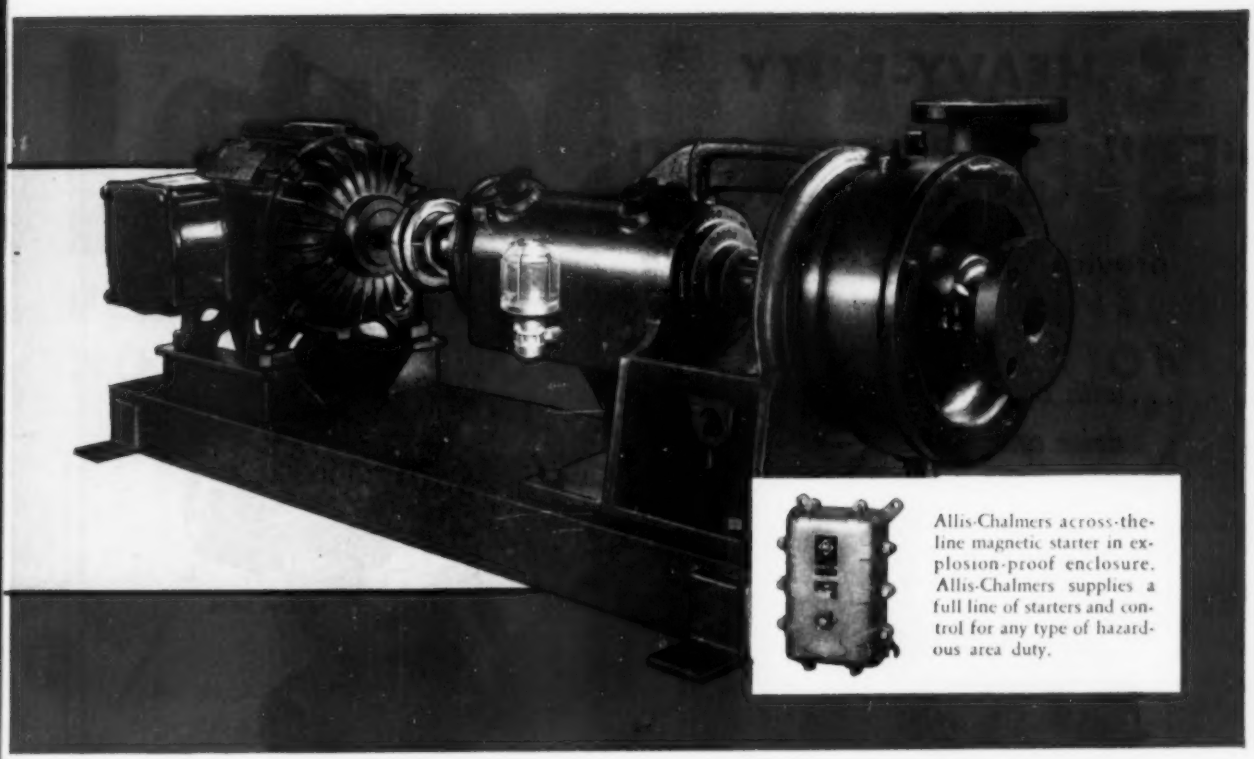

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The complete unit is guaranteed by one reliable manufacturer, Allis-Chalmers. No buck passing on performance responsibility. Nearly a hundred Allis-Chalmers Certified Service Shops provide factory-approved service in every large industrial area.

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Get help on your pumping problems by calling an experienced Allis-Chalmers pump application engineer at your nearby Allis-Chalmers District Office.

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Texrope is an Allis-Chalmers trademark.

ALLIS-CHALMERS

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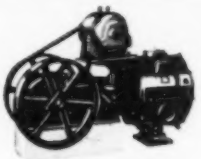
HEAVY-DUTY
"ES" COMPRESSORS

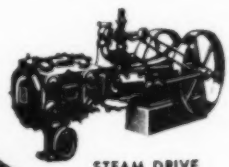
provide maximum efficiency in a
WIDE RANGE OF APPLICATIONS

. . . with unusual flexibility of drive and cylinder arrangements

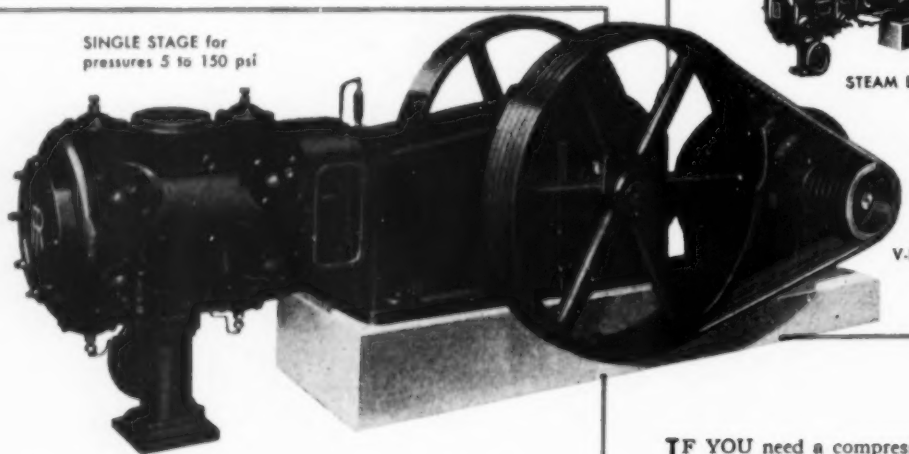


OVERHEAD MOTOR

DIRECT-CONNECTED SYNCHRONOUS MOTOR

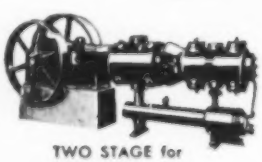


STEAM DRIVE

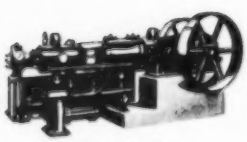


SINGLE STAGE for pressures 5 to 150 psi

V-BELT DRIVE

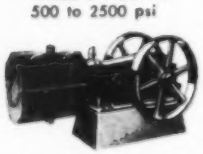


TWO STAGE for 150 to 500 psi



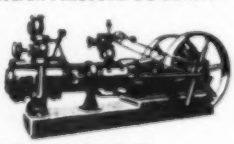
THREE STAGE for 500 to 2500 psi

DRY VACUUM PUMPS . . . single or two stage



STEAM-PRESSURE BOOSTERS

NON-LUBRICATED CYLINDERS for oil-free air or gas



REFRIGERATION UNITS for ammonia or other refrigerants

IF YOU need a compressor for any of the following purposes you should consider the Type "ES" compressor . . . a standardized, yet extremely flexible compressor built by Ingersoll-Rand, the pioneer compressor builder.

- To compress air or gas to any pressures between 5 and 2500 psi, or for pulling vacuums. (Stock cylinders are normally available for all frame sizes, see illustrations.)
- For capacities requiring from 5 to 125 horsepower. (Six frame sizes are available.)
- For continuous full-load operation day after day, week after week.
- For handling poisonous, inflammable, or other gases where leakage must be avoided.
- Where compressed air or gases must be free of all traces of oil. (Type NL cylinders require no oil, glycerine, grease or water for lubrication.)
- Where a future change in pressure conditions may call for a change in cylinder sizes.
- Where power cost is an important factor.
- To act as an economical standby unit for larger compressors whose full capacity is not required at all times.

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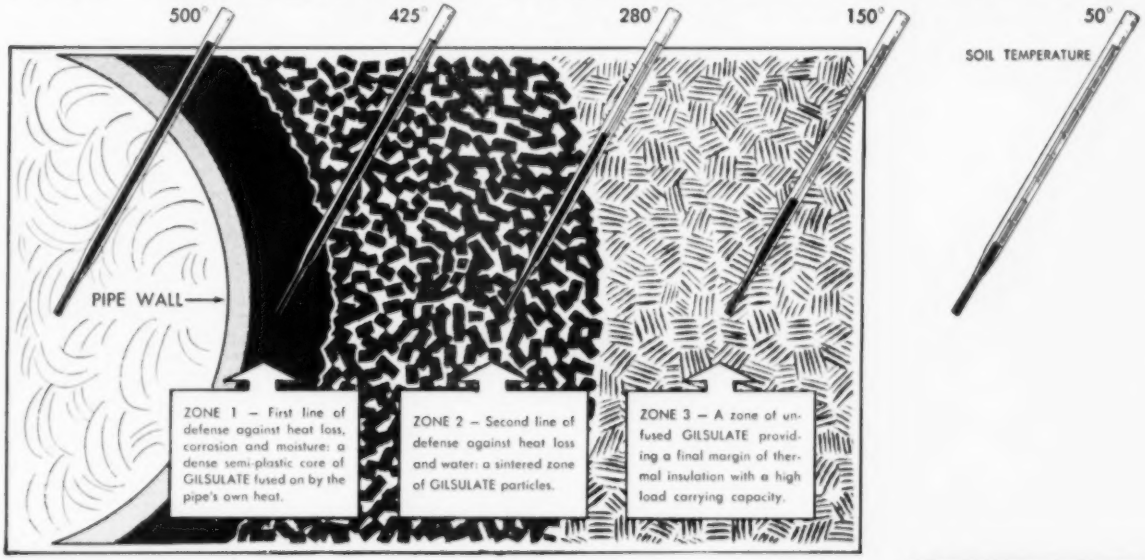
COMPRESSORS • TURBO-BLOWERS • ROCK DRILLS • AIR TOOLS • CENTRIFUGAL PUMPS • CONDENSERS • OIL AND GAS ENGINES

Lowest Cost

PER INSTALLED LINEAR FOOT OF ANY HOT UNDERGROUND PIPE INSULATION


500°
425°
280°
150°
50°
SOIL TEMPERATURE
PIPE WALL
ZONE 1 – First line of defense against heat loss, corrosion and moisture: a dense semi-plastic core of GILSULATE fused on by the pipe's own heat.
ZONE 2 – Second line of defense against heat loss and water: a sintered zone of GILSULATE particles.
ZONE 3 – A zone of unfused GILSULATE providing a final margin of thermal insulation with a high load carrying capacity.

GILSULATE®... the triple-zone insulation that fuses itself into lifetime protection for hot underground pipes. Water-proof, corrosion-proof, root-proof, acid/alkali-proof.

Compare your present insulation methods with Gilsulation:

1. Pour Gilsulate granules out of the bag onto the pipe; tamp it down.
2. Backfill: *the job is insulated!*

Gilsulate—nature's own insulation—is a unique, solidified hydrocarbon that virtually installs itself. Normal pipe-heat (up to 520° F) does the rest—fuses the Gilsulate to the pipe in hours, forming a massive circular solidified sheath.

Gilsulate costs less installed per linear foot *than any other underground pipe insulation*... it's easiest to use... and has been tested in scores of the country's largest and most important installations.

Some additional Gilsulate advantages:

- *3 grades available*—220° to 520° F
- *needs no sleeves* or mechanical sheaths
- *requires no mixing* or special handling
- *can't be punctured* – leave rocks in backfill
- *pipe expands and contracts* within Gilsulate structure
- *proved in actual use* in hundreds of new construction and replacement installations

Send coupon for descriptive literature.

AMERICAN GILSONITE COMPANY
SALT LAKE CITY, UTAH
Affiliate of Barber Oil Corp. & Standard Oil Co. of California

No skills necessary—simply pour Gilsulate out of 100 pound bags, tamp and backfill. Can be used under any and all conditions—no matter how many pipes, whatever the space.

GILSULATE®

THE TRIPLE-ZONE INSULATION
FOR LIFETIME PROTECTION
OF HOT UNDERGROUND PIPES.

American Gilsonite Company
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Please send me descriptive literature on Gilsulate.

NAME .....

TITLE .....

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Hand-tailored to any size you need...

...Goetze Heat Exchanger Gaskets are precision-made for longer service

Whether your requirements call for heat exchanger gaskets larger than 100" in diameter, or smaller than 10", you can get the exact size you want . . . hand-tailored to the shape you need . . . simply by specifying "Johns-Manville Goetze."

And because they're *precision-made*, you'll find these better gaskets provide the effective sealing and longer life that make them actually cost less in the long run. Each gasket is carefully constructed in every detail to assure accuracy of fit . . . to provide ample lap widths and uniform rib widths . . . and to prevent trouble-making wrinkles or cracks on the corners.

If you're having trouble with persistent joint leakage and frequent gasket replacements, find out how little it costs to have Goetze Heat Exchanger Gaskets tailored to your requirements. Your blueprint or template will bring a prompt estimate. Address Johns-Manville, Box 60, New York 16, New York.

Johns-Manville *Goetze* GASKETS

THERE'S A JOHNS-MANVILLE PACKING AND GASKET FOR EVERY SERVICE

Why we took a Jaguar to Detroit

Records of speed and endurance races won show that under the flowing lines of the Jaguar automobile is an unusually fine engine . . . an engine we were more than ordinarily curious about.

You see, we had heard reports that despite this engine's high power output, its octane requirements were quite modest. And to our way of thinking, anything that might stimulate the building of more mechanical octanes into engines is a step in the right direction.

So we brought a Jaguar engine to our Detroit Research Laboratories and put it through a series of tests. The reports were true. It did have a relatively low octane requirement. And we felt pretty sure our friends in the engineering departments of the automobile manufacturers would be interested in our findings.

(*Continued on next page*)

ETHYL
ETHYL CORPORATION

Printed in U. S. A.

Why we took a Jaguar to Detroit

(Continued from preceding page)

We took the Jaguar engine down, and exhibited the parts at special meetings for automotive people. Of course, American manufacturers producing cars in tremendous volume face entirely different problems from those of a maker of a limited-edition sports car. But judging from the interest and discussion, these meetings were a tremendous success.

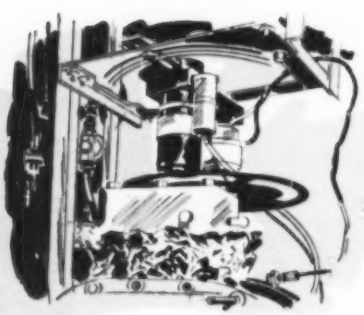
These Jaguar meetings are just an example of Ethyl's work to make the most efficient use of every octane produced by the petroleum industry. We believe they illustrate an interesting point: because of its unique position in the oil industry, Ethyl is able to work for the industry and be of material assistance in the all-important job of fitting engines to fuels and fuels to engines.

And in the last analysis, cooperation between the automotive and petroleum industries is the key to future progress in motor transportation.

ETHYL CORPORATION

NEW YORK 17, NEW YORK

WORTH NOTING



A radiation pyrometer—a special temperature measuring device—has been adapted by the Ethyl Research Laboratories . . . to aid in the study of engine hot spots.

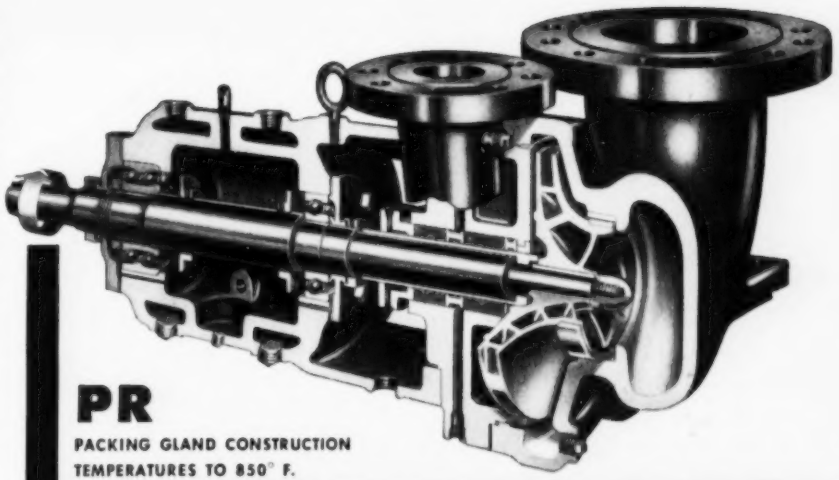
George Washington won freedom for our country with only 17,000 soldiers. If all the people who have seen Ethyl's dealer-education show "The Product Sales Clinic" were gathered together, they would equal six Continental Armies!

Ethyl-owned tank cars traveled more than 13 million miles last year to make certain that customers received "Ethyl" antiknock compound when and where they needed it!

Ethyl Service is backed by 30 years of antiknock experience

BUY PUMPS OUT OF STOCK FOR "CUSTOM" PUMP JOBS

These rugged, center-line-mount pumps are available in a complete range of sizes, many of which are available from stock. Peerless application experience shows that up to 70% of refinery hot oil pump requirements can be met by these two Peerless pump designs. In addition to the choice of either packing gland or mechanical shaft seal construction, features common to both pumps include: use of spacer type coupling to permit liquid and disassembly without disturbing piping; oversize shafts; oil lubricated, heavy duty, radial and thrust bearings; spot electric welded case and impeller-wear rings; end or top suction design; extra low NPSH requirements. Mail coupon for descriptive bulletin today.



PR

PACKING GLAND CONSTRUCTION
TEMPERATURES TO 850° F.

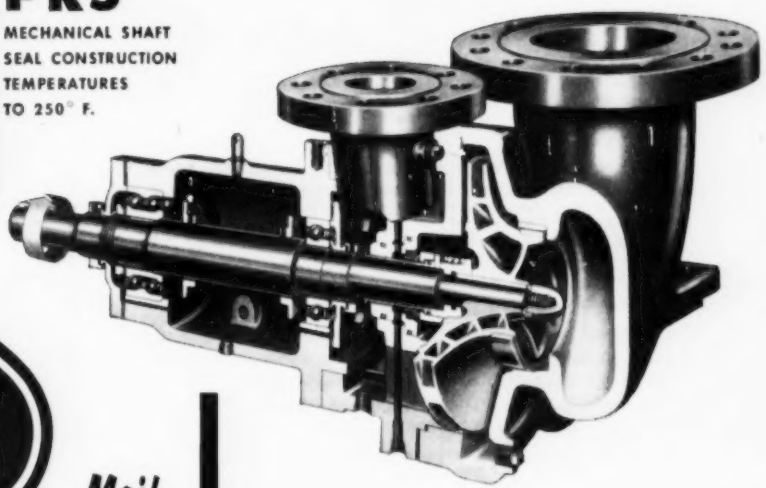
2 designs

TO CHOOSE FROM...

70% OF ALL YOUR HOT OIL PUMPING REQUIREMENTS CAN BE SUCCESSFULLY MET WITH THESE STANDARD PEERLESS PUMPS

PRS

MECHANICAL SHAFT SEAL CONSTRUCTION
TEMPERATURES TO 250° F.



CHARACTERISTICS at a glance

Capacities	up to 1000 gpm
Operating Heads	up to 625 feet
Case Pressures	up to 600 psig
Drives	horizontal electric motor is standard; other types as required
Material of Construction	liquid end can be of any material suitable to intended service

PEERLESS PUMPS

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Mail COUPON *Now!*

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FOOD MACHINERY AND CHEMICAL CORPORATION

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Please send us a copy of Bulletin No. B-1605 describing Peerless Type PR and PRS Pumps.

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Part of the welding floor at Grinnell's Warren, Ohio Plant

How shop fabrication of piping

keeps costs down...quality up!

When you specify piping fabricated in Grinnell shops, you are ALL to the good.

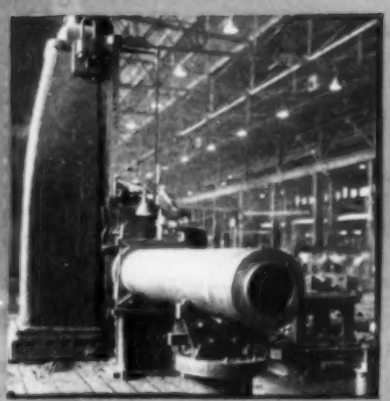
Here's why: — Included in the price (which is determined in advance) are such items of expense as:

- Interpretive engineering
- Shop sketches and planning
- Procurement of materials
- Heat, light, power, water, compressed air, expendable tools and supplies

But Grinnell even goes further. Grinnell finances material inventories and payrolls for you; carries insurance; makes no charges for waste material or spoilage.

On the production side, too, you benefit. Piping fabricated in Grinnell shops is done under ideal conditions, with modern equipment, by personnel qualified for each class of work. It is rigidly inspected and tested to meet customer's specifications and all applicable codes. Before shipment, it is cleaned inside and outside and painted. It is squared to dimensional tolerances, so that sub-assemblies can be erected at the job site quickly and easily.

You can count on it . . . Grinnell shop fabricated piping *guarantees* maximum quality and economy.



Heavy wall pipe being machined to the proper welding bevel on a post mill

Welding (induction heating coils in place for preheat, welding heat and stress relieving.)

GRINNELL

WHENEVER PIPING IS INVOLVED

Grinnell Company, Inc., Providence, Rhode Island • **Coast-to-Coast Network of Branch Warehouses and Distributors**

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

Forged to Fit Petroleum Problems . . .

WATSON-STILLMAN SOCKET-WELDING FITTINGS

Have you discovered the economy and low maintenance cost of an all-welded piping system? If so, you are already in line for still further advantages from this type of system when you start specifying Watson-Stillman Double-diamond FORGED STEEL SOCKET-WELDING FITTINGS.

Made on special machines from solid forgings whose material is selected for good weldability and in strict accordance with the required specifications.

W-S Fittings give you joints stronger than the pipe itself. Deep sockets, ease alignment, provide ample come and go for pipe sections, minimize field cutting and assembly problems.

Design of fitting is such that flow is smooth and uninterrupted by "icicles" or turbulence at the joint. Available in carbon, stainless and chrome-moly alloy steels.

For those applications where screw-end fittings are indicated, you can get the same superior physical and chemical qualities in the steel analyses you want by specifying W-S FORGED STEEL SCREW-END FITTINGS. Look for the double-diamond trademark. Write for literature.

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One source... for all your

All these requirements can be met with flat-rolled U·S·S CARILLOY steels

	PLATE	STRIP	SHEET
METHODS OF MANUFACTURE			
Electric Furnace	X	X	X
Open Hearth	X	X	X
SPECIAL QUALITIES			
Aircraft	X	X	X
Armor	X		
Bearing	X	X	X
Drawing	X	X	X
Flange and Firebox	X		
Metal Cutting Saw		X	X
Razor Blade		X	X
Other Special Qualities	X	X	X
TREATMENTS: INDIVIDUAL OR COMBINED			
Quenched and Tempered	X	X	X
Annealed	X	X	X
Spheroidize Annealed	X	X	X
Normalized	X		
Stress Relieved	X		
CONDITIONS: INDIVIDUAL OR COMBINED			
Hot Rolled	X	X	X
Straight Lengths	X	X	X
Coiled	X	X	X
Flattened or Leveled	X	X	
Gas or Special Cutting	X		X
Pickled	X		
Sand Blasted	X	X	X
Oiled	X	X	X
Formed, Machined or Other Special Conditions	X	X	
SPECIFICATIONS—REQUIREMENTS: INDIVIDUAL OR COMBINED			
Grain Size	X	X	X
Macro-Etch	X		
Micro-Cleanliness	X	X	X
Restricted Chemical Analysis	X	X	X
Special Mechanical Tests	X		
Impacts	X	X	X
Tensile Tests	X	X	X
Bend Tests	X	X	X
AISI-Govt.-ASTM-SAE	X	X	X
Special Specifications	X	X	X
	X	X	X
	X		
	X		
	X	

alloy steel plate, sheet and strip!

Just specify U·S·S CARILLOY steels

Glance down the accompanying list of qualities, treatments, conditions and specification requirements that can be furnished in U·S·S CARILLOY plate, sheet and strip. This is the widest selection of flat rolled Alloy Steel products you can secure from any one producer. Our unmatched mill flexibility and size range enable you to order anything from a razor blade strip to a plate for a battleship. This streamlines your purchasing, assures consistent quality and simplifies your manufacturing problems. Making United States Steel your source of supply gives you access to *expert metallurgical assistance.*

Any time you have a metallurgical or fabricating problem, call in a United States Steel Service Metallurgist. He has an extensive knowledge of all types of Alloy Steels and can help cut costs by offering suggestions to assist your engineering and production people.

It will pay you to investigate our facilities—submit your inquiries to our nearest sales office, or send the coupon.

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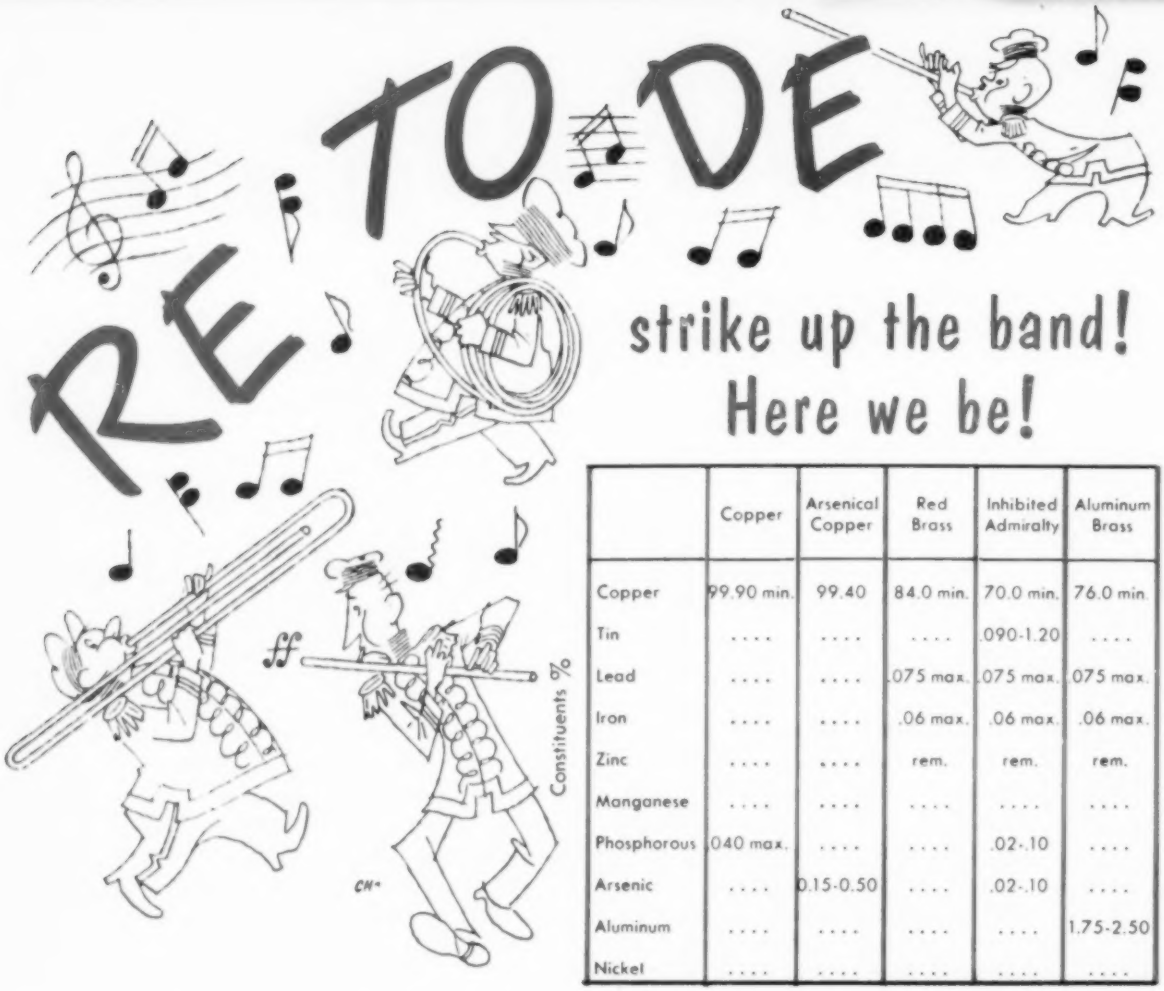
Company .....

Address .....

City ..... State .....

UNITED STATES STEEL



	Copper	Arsenical Copper	Red Brass	Inhibited Admiralty	Aluminum Brass
Copper	99.90 min.	99.40	84.0 min.	70.0 min.	76.0 min.
Tin	....	....	....	.090-1.20	....
Lead	....	....	.075 max.	.075 max.	.075 max.
Iron	....	....	.06 max.	.06 max.	.06 max.
Zinc	....	....	rem.	rem.	rem.
Manganese	....	....	....	....	....
Phosphorous	.040 max.	....	....	.02-.10	....
Arsenic	....	0.15-0.50	....	.02-.10	....
Aluminum	....	....	....	....	1.75-2.50
Nickel	....	....	....	....	....

RE... TO DE..... READY TO DELIVER

Adding the missing letters (indicated by dots) you make the entire line read:

Ready to deliver to you the condenser tubing you require in any of the alloys and popular sizes shown on the chart above.

You'll want to specify Wolverine condenser tubing because its entire manufacture is subjected to more controls than most any other tubing. Every possible attention is paid to wall thickness and lengths, and the tubing undergoes special quality tests before it is released for shipment. Close tolerances, quality testing and special handling (all routine matters with Wolverine) go to make this condenser tubing the outstanding performance-standard in the industry—The tube to specify for dependability . . . Wolverine.

WOLVERINE TUBE DIVISION
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Manufacturers of Quality-Controlled Tubing

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Plants in Detroit, Mich. & Decatur, Ala. *Sales offices in Principal Cities*

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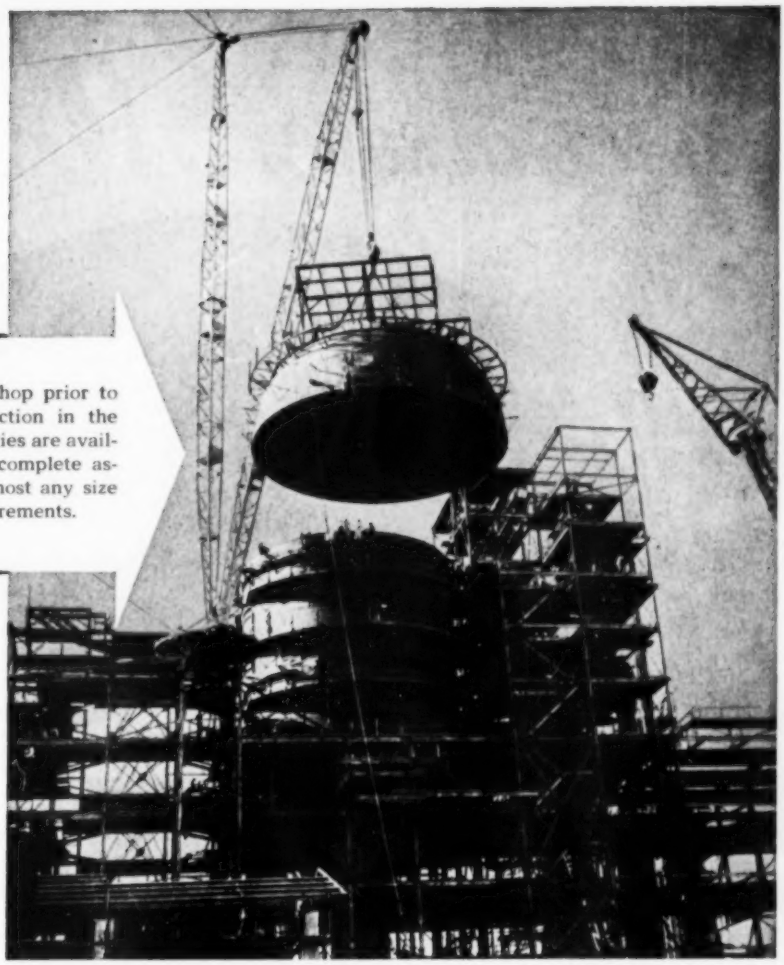


Precision assembly in the shop prior to shipment expedites construction in the field. Cranes and other facilities are available at Newport News for complete assembly of weldments of almost any size to meet the customer's requirements.

Shipbuilder "launches" new vessel

It's a pressure vessel in an overseas petroleum refinery. And it caps *sixty-seven* years' experience by the Newport News Shipbuilding and Dry Dock Company. Sixty-seven years, building just about any kind of vessel you could name. And at a price.

They've fabricated millions of tons of steel. They handle weldments in almost any size or shape. They machine, weld and stress relieve.

Another development: fabrication of corrosion-resistant alloy, clad, and other special steels. You know how important they are today.

What's more, there's plenty of equipment – foundry, machine shop, fabrication and erecting – to build anything from a cat cracker to a bubble tray. And enough engineering skill and shop force experience to handle the job as you want it done. And at reasonable cost.

It would pay you to ask yourself, "What could Newport News build for us?" Find the answer in the brief, easy-to-read, photo-and-caption pages of *Facilities and Products*. See for yourself what Newport News is doing. And what equipment they use.

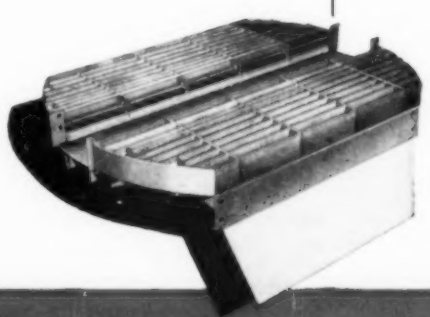
Send for *Facilities and Products*, free, today!

NEWPORT NEWS

SHIPBUILDING AND DRY DOCK COMPANY
Newport News, Virginia

You can save 30% to 50% of your tower costs

Design Factors	Bubble Trays	"Benturi" Kaskades
Low vapor thruput	+	−
High vapor thruput	−	+
Low liquid thruput	+	−
High liquid thruput	−	+
Low pressure drop	−	+
High pressure drop	+	−
High pressure towers	−	+
Low pressure towers	+	+
Alloy or alloy-clad towers	−	++
Shop fabricated towers	−	+
Field fabricated towers	−	++



Check your requirements on this simple chart. While any one of the "plus" features justify the economy of Koch "Benturi" Kaskade trays, a combination of these conditions provides a "bonanza" to the operator. We'll be glad to give you data on "Benturi" installations to fit your requirements. No obligation.

KOCH ENGINEERING COMPANY, INC.

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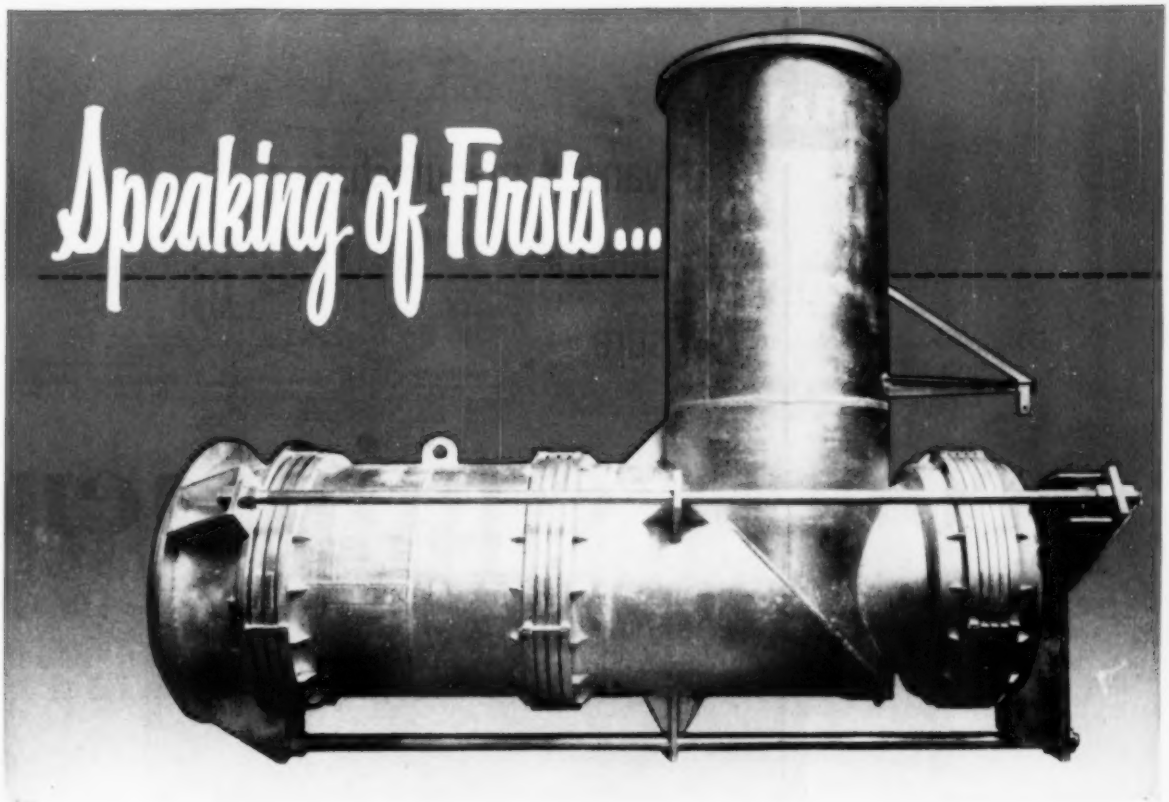
Myers-Bogwell Co.
Wright Building

Koch International,
16 Rue Auber,
Paris, France.



Recently, Zallea was given the assignment of developing a group of 48-inch expansion joints for flight propulsion test facilities on a classified defense project. The rigid technical specifications of this advanced application required "tailor-made" units for the job, so Zallea engineers analyzed the problem and designed the unusual-looking joint pictured above . . . the first of its kind. Actually, it is a Balanced Pressure, Universal Self-equalizing expansion joint, originally developed by Zallea engineers in 1945, operating at 165 psi and incorporating internal stainless steel turning vanes to provide a smooth flow of gases through the right angle bend. The unit absorbs 3" axial and 1.27" lateral movements through a temperature range from −100° F. to +650° F. No anchors are required since this arrangement neutralizes end thrust developed by internal pressures.

This example is representative of our ability to cope with the most difficult expansion joint problems. It is our business to specialize in the design and manufacture of one product only—expansion joints—and over the years we have learned how to solve the "tough ones" effectively and quickly.

Zallea Expansion Joints are available in diameters from 3 inches to 30 feet . . . for temperatures from sub-zero to 1600° F. . . . for pressures from vacuum to 300 psi in standard designs, and up to 2,000 psi in special designs.

The next time you are faced with an expansion problem, get in touch with us. We will be glad to survey your situation and recommend the most practical and economical solution. Zallea Brothers, 890 Locust Street, Wilmington 99, Delaware.

For detailed information on Zallea Expansion Joints and services write today for a free copy of Bulletin 351.

Zallea
EXPANSION JOINTS

WORLD'S LARGEST MANUFACTURERS OF EXPANSION JOINTS

B&W

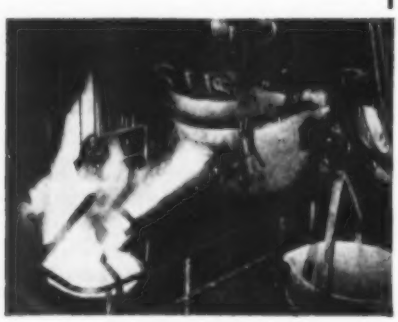
advanced manufacturing
techniques
assure

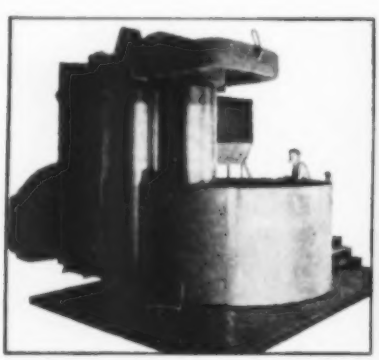
process equipment

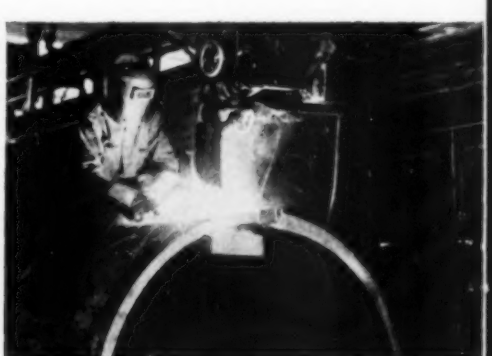
Uncompromising attention to detail during every manufacturing operation is the user's guarantee of satisfaction with B&W Process Equipment.

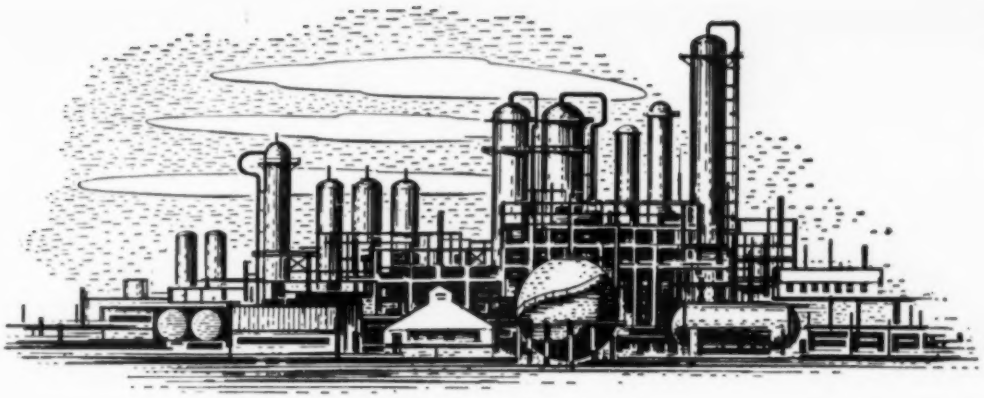
Many of the advanced production and testing techniques used, in casting, forming, machining, welding and stress relieving, require specially designed equipment. Much of this equipment was originally developed by B&W.

Intensive research and development, aided by long experience and first-rate facilities, have earned for B&W Process Equipment a fine reputation across the nation and abroad. The Babcock & Wilcox Company, Process Equipment Dept., Barberton, Ohio.

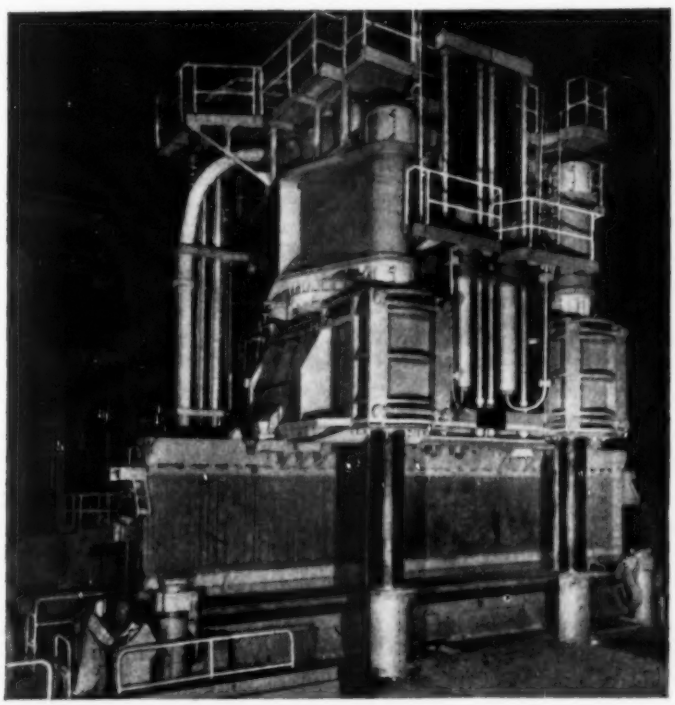




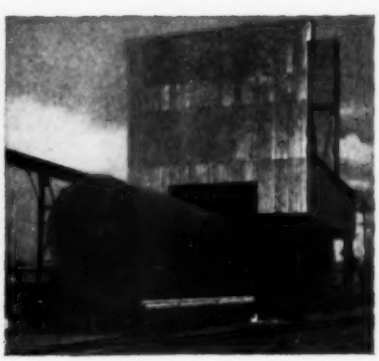




built to last



New hydraulic press, installed at B&W's Barberton, Ohio, works, is used to form extra heavy plate and to pierce billets. It is the largest of its kind, and has a capacity of 6500 tons plus.



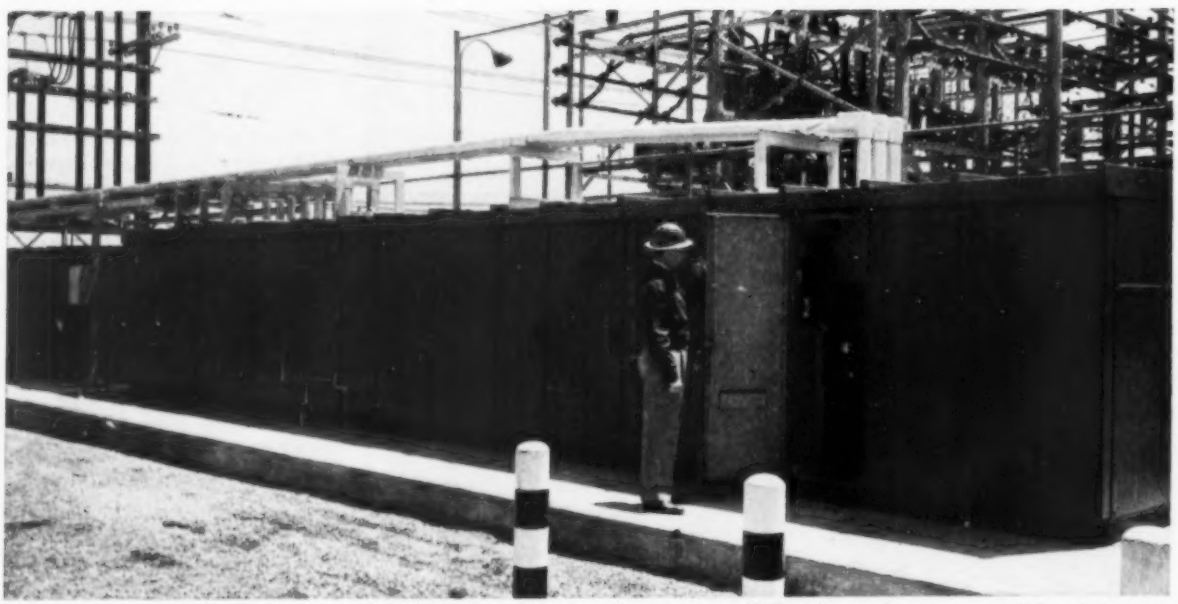
BABCOCK & WILCOX

S-415

"WORK HORSE" LINEUP of totally-enclosed, fan-cooled Tri-Clad* motors under topping units meet rigid requirements for continuous processing and safety. Cast-iron frame construction helps protect punchings, windings, and rotating parts from dusts, moisture, and corrosive atmospheres. Each motor has a matching explosion-proof push-button station.

*Registered Trade-mark of General Electric Company

System-planned electric equipment



COMPACT, OUTDOOR METAL-CLAD SWITCHGEAR in foreground is the main distributing point of power to Union Oil's Wilmington refinery. Providing primary circuit protection, these compact G-E units are factory-assembled and shipped ready to install. They're simple to operate and maintain because of a fast, vertical-lift system of breaker removal.

TOTALLY-ENCLOSED, CLASS 1 GROUP O G-E MOTORS are designed for corrosive and hazardous refinery locations—like these two Tri Clad units driving transfer pumps.

EXPLOSION-PROOF motor starters have cast-alloy enclosures, helps protect against hazards. They are centralized on one rack for easy accessibility and a better distribution system.

helps keep throughput high at Union

CENTRALIZED G-E LIMITAMP CONTROL, located in a non-hazardous area, starts and protects motors driving refinery equipment.

Two new topping units at Union Oil's Wilmington refinery kept on-stream by G-E power and drive equipment

Recently, the Union Oil Company wound up a $27,000,000 expansion program at their Wilmington, Calif. refinery by putting two new 20,000 bbl.-per-day topping units and the nation's largest vacuum flasher into action.

To help maintain this output on a continuous basis, Union Oil and General Electric engineers co-ordinated all drive and power distribution equipment—"system-planned" it—to the plant's specific processing needs.

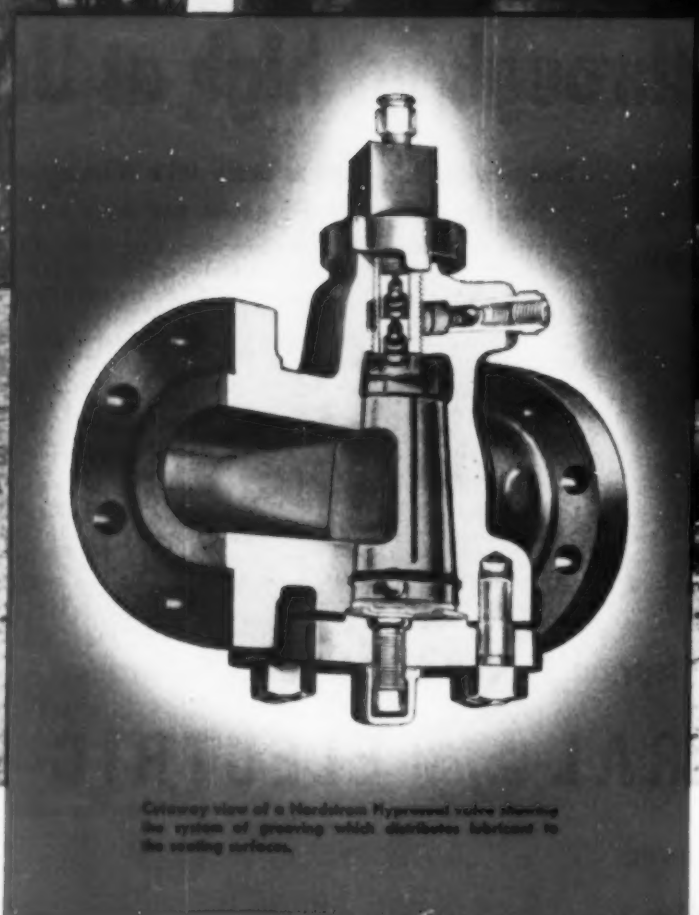
G-E application engineers, experienced in refinery practices, are ready to assist you and your consultants in planning an efficient electrical system.

TO HELP CUT YOUR POWER DISTRIBUTION COSTS be sure to see the new full-color sound slidefilm, "The Vital Link." It's another G-E "More Power to America" program. Ask your G-E apparatus sales representative to arrange a showing. General Electric Company, Schenectady 5, New York. 661-42

Engineered Electrical Systems for Petroleum Refineries

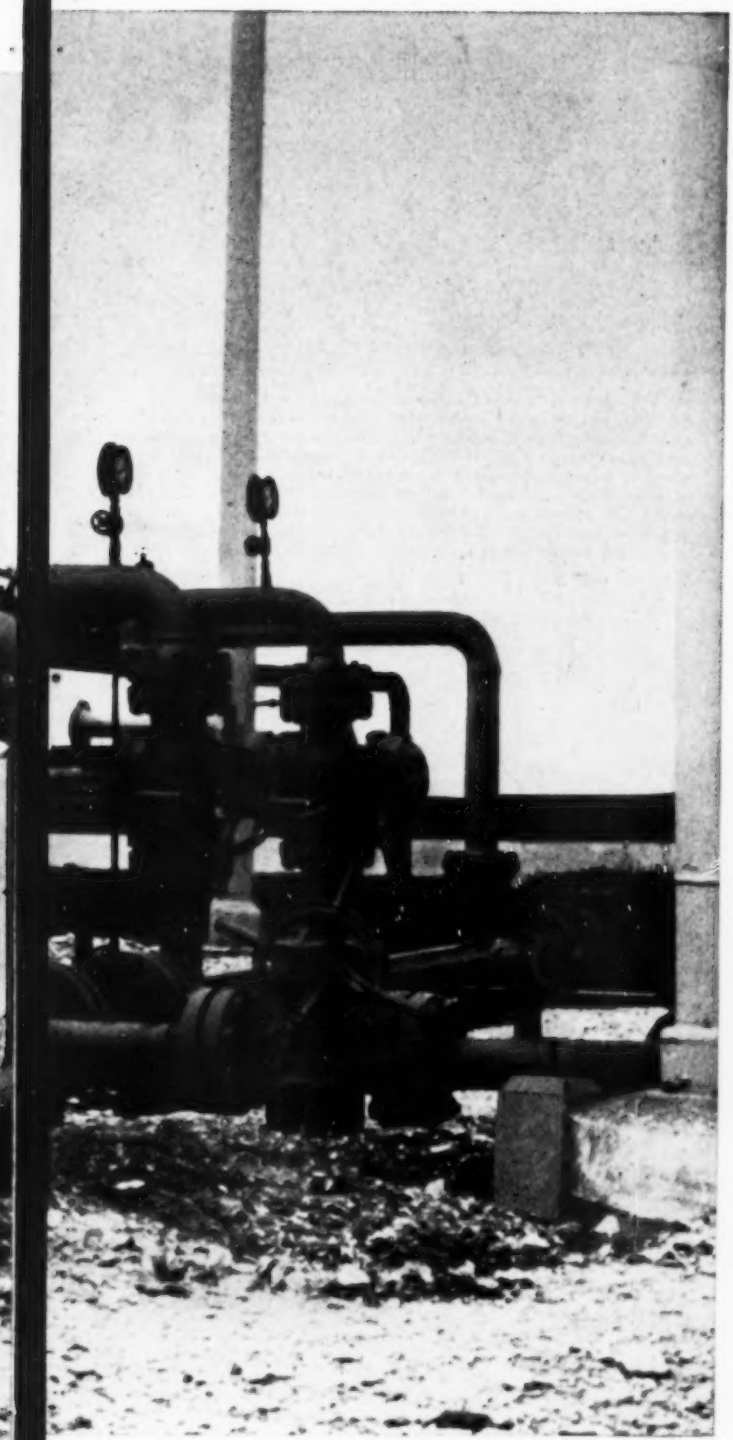
GENERAL ELECTRIC

Handling Petrochemicals? . .



Cutaway view of a Hardstrom Hypersteel valve showing the system of grooving which distributes lubricant to the seating surfaces.

. . . Then read these facts on



A manifold of Nordstrom Hypreseal valves installed on high pressure ethylene gas lines in a large Southwestern petrochemical plant.

NORDSTROM *Lubricant-Sealed* VALVES

ETHYLENE . . . PROPYLENE . . . SYNTHESIS GAS FOR AMMONIA AND METHANOL PRODUCTION — these are some of the more common petrochemical services that Nordstroms handle better than any other valve.

There are a number of reasons for Nordstroms' superiority on petrochemical services—

First, Nordstrom valves, with the exclusive "Sealdport" principle of lubrication, *will not leak* on light hydrocarbons, the basic raw material of this industry.

Second, the vital seating areas of a Nordstrom valve are protected against corrosion and abrasion. This feature means *longer valve life.*

Third, Nordstrom valves, when installed throughout a plant, are *economical* in both the initial and operating costs.

Finally, Nordstrom Hypreseal valves are especially designed to *handle the high pressures* so common in petrochemical services.

These facts explain why many new petrochemical operations are standardizing on Nordstrom valves. For further information, contact your Nordstrom representative or write: Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Canadian Licensee: Peacock Brothers Limited

ROCKWELL Built
Nordstrom Valves
Lubricant-Sealed for Positive Shut-Off

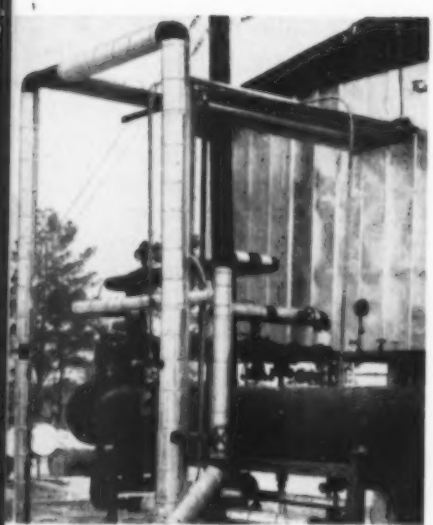
Another ROCKWELL product

IN PETROLEUM REFINERIES like this a new kind of aluminum jacketing is used to protect the insulation on hot and cold lines. It is known as Childers Aluminum Jacketing and is especially engineered to combine the long life and weather resistance of aluminum with a low first cost. It goes on quick and easy—can be used and re-used. It is made of tough but flexible .006" 35 aluminum alloy, so it handles easily and requires no shop forming.

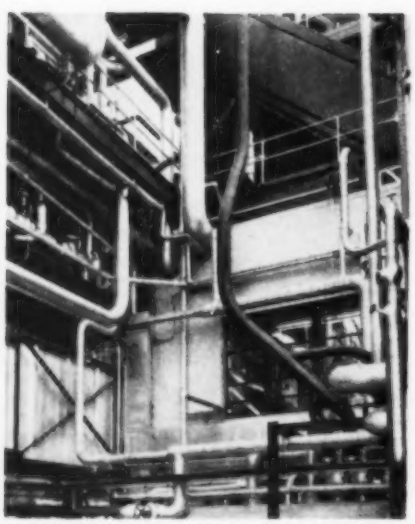
IN CHEMICAL AND PAPER plants: engineers are finding new uses for this easy-to-handle jacketing. Childers Jacketing here is in use at Scott Paper Company's tremendous Chester, Pa., plant. The insulated line passes between fast moving rolls carrying the felt used in paper making both above and below the line. The Aluminum Jacketing protects against paper dust and water, both of which are always present in the manufacture of paper. The jacketing also appreciably diminishes the possibility of the spread of fire which might strike across ordinary canvas jacketing.

Engineered for outdoor lines — new, low-cost aluminum jacketing now used in 567 processing plants

The new kind of aluminum jacketing for insulated lines shown in the pictures on this page is Childers Aluminum Weatherproof Jacketing. Write for samples and full details, no obligation. Childers Manufacturing Co., Dept. PR-17, 3620 W. 11th St., Houston 8, Texas.



IN FOOD PROCESSING plants such as this Minute Maid Corp. unit at Plymouth, Fla., Childers Jacketing is useful for both indoor and outdoor installations. Its clean, shining appearance and ease of washing are extra advantages.



IN POWER PLANTS—indoors and out—Childers Jacketing is an ideal material for protecting insulation. This is a big outdoor installation in the South. This jacketing needs no painting, and the gleaming aluminum surface makes for "good housekeeping" in any utility or institutional power station.

ALMOST ANYWHERE you have insulated lines in your processing plant, consider this specially engineered jacketing. It is flexible, easy-to-handle; yet it has the appearance values and the weather resistance that are inherent in aluminum. Write to address shown above for full details.

Advertisement

REFINERY PROCESS NEWS

PUBLISHED BY REFINERY PROCESS DIVISION, THE M. W. KELLOGG COMPANY — DECEMBER 1953

Chile's First Refinery Now Well Underway

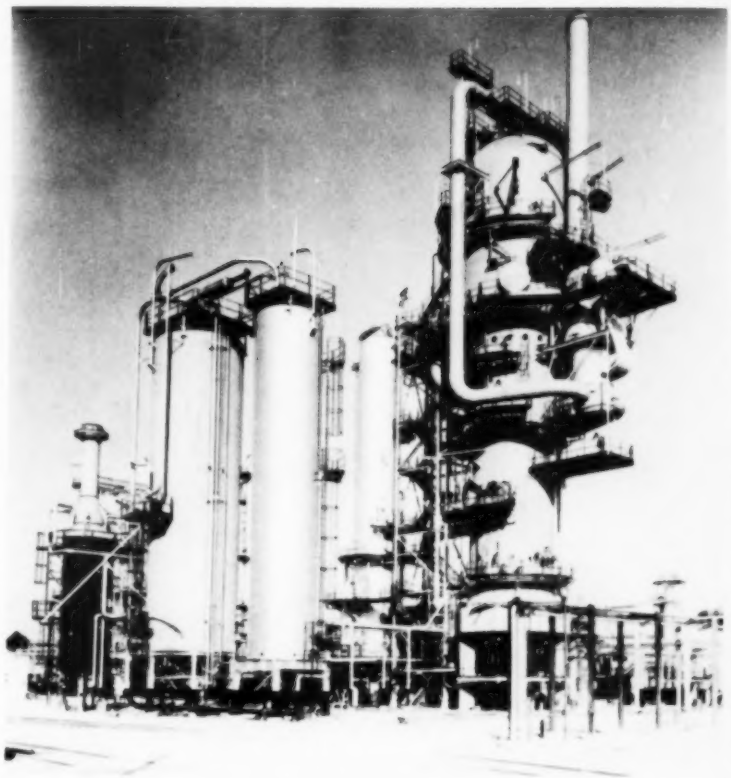
Construction is now well underway on Chile's first petroleum refinery. It was designed by Kellogg and is now being erected under supervision of Kellogg Pan-American Corporation. The new plant will be located ten miles north of Valparaiso and is expected to be on stream by mid-1954.

This $10,000,000 refinery, being built for Expresa Nacional del Petroleo, will have a crude charge capacity of 20,000 BPD and will employ the most modern type of combination thermal equipment to process either indigenous or imported petroleum.

Processing steps include topping, visbreaking, gas oil cracking, thermal reforming, gasoline stabilization and treating. In addition to motor gasoline, the refinery will produce LPG, tractor distillate, kerosene, two grades of diesel oil and heavy fuel oil.

This is only one of several major projects currently underway in South America by Kellogg. Others include a complete refinery in Argentina; two refineries (of 5,000 BPD and 10,000 BPD capacities) and nitrogen fertilizer facilities at three different locations in Brazil.

Shown in the foreground is the stabilizer tower of the new refinery while in the background is the framework of the furnace for the naphtha reformer.



First Model "B" Orthoflow Cracker Goes on Stream Smoothly at Toledo

The first of Kellogg's new Model "B" Orthoflow Fluid catalytic cracking units has now been put on stream at Pure Oil's Toledo refinery. Reports from the first three weeks of operation indicate that the new design is completely successful. Catalyst loss is at a minimum, coke-to-conversion ratio is low, and flexibility excellent.

This new model is one of two versions of Kellogg's exclusive Orthoflow design both of which involve the single vessel construction with straight-line flow of catalyst. The Model "B" Orthoflow, as differentiated from the Model "A," has the regenerator placed above the reactor. As a result, the regenerator is operated at a lower pressure than in the Model "A", which brings about savings in direct operating costs due to reduced horsepower requirements for compression of regenerative air.

For example, in the Model "A", pressure of about 18 pounds is required in the regenerator with a simultaneous pressure of ten pounds in the reactor in order to maintain the optimum circulation of catalyst from one zone to the other. In the newer "B" design, the reactor pressure is held at about 15 pounds while the regenerator is operated at a pressure in the order of seven pounds—retaining the same eight pound differential while simultaneously transferring the major compressor requirements to the lower pressure side of the operation.

In addition to obtaining a significant decrease in the compressor horsepower required to supply combustion air to the regenerator, this arrangement has another advantage. The higher reactor pressure permits a slight decrease in the size of this vessel as well as in that of the fractionator.

(Continued on reverse side)

REFINERY PROCESS NEWS

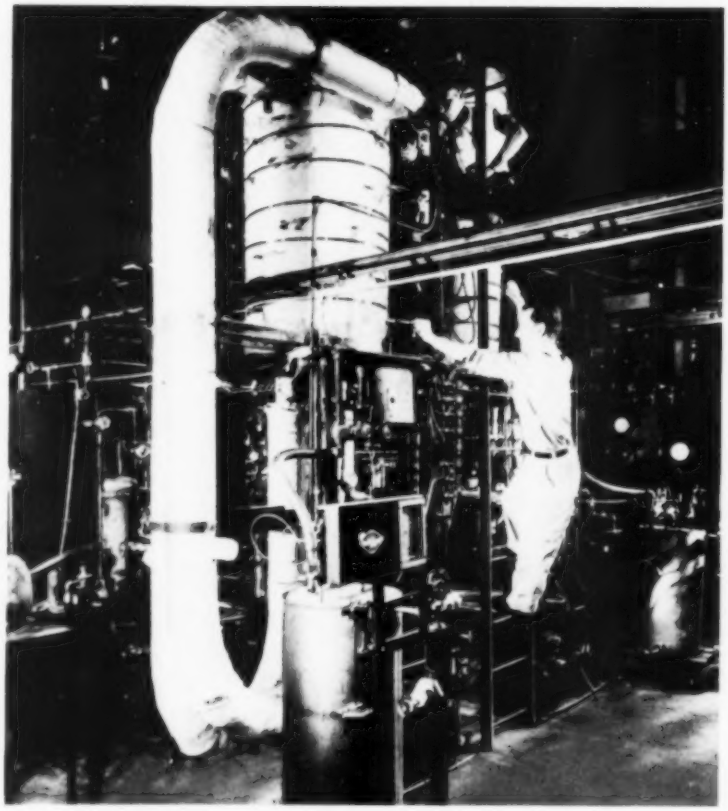
CONTINUED FROM PRECEDING PAGE

Model "B"...continued

While on the surface it would appear that the Model "B" should always be preferred over the Model "A" this is not necessarily the case. The final selection is inevitably dependent upon the individual refiner's processing requirements.

Regardless of which type a refiner installs, commercial operating experience with the five Orthoflow units already built by Kellogg clearly establishes the superiority of this new design. For example, just recently a Model "A" design was placed on stream abroad. The ease with which the unit can be started up and operated is indicated by the fact that Kellogg's operators were released only six weeks after placing the plant on stream. At that time the unit had completed a thoroughly satisfactory demonstration run and had been accepted by the refiner. Considering that the Kellogg operators faced a language barrier in training the refiner's operators in addition to dealing with equipment of foreign manufacture, there's slight question but that this short start-up and indoctrination period constitutes an excellent performance record.

Meanwhile, six other Orthoflows are underway. With capacities varying from less than 2000 to more than 28,000 BPD in fresh feed, they are going up on sites in as widely separated sections of the world as Australia, Texas, Pennsylvania, Yugoslavia and Canada.



New Pilot Plant for Data on Platinum Catalyst Life

Shown here is a new four-barrel-per-day pilot plant Kellogg has just completed in its extensive pilot plant laboratories in Jersey City. It is currently being used to pinpoint the ultimate life of the regenerative-type Sinclair-Baker RD-150 platinum catalyst.

Two commercial units employing the RD-150 catalyst are now underway, one on the East Coast and one in the Midwest.

Foundation Work Marks Site of New Fluid Hydroformer

Foundations are well along on this large Fluid Hydroformer—one of two currently being erected for Cities Service. This one at Lake Charles is scheduled for completion in 1954. The other is being built at East Chicago.

Still a third Fluid unit is now being engineered for another refiner located in the Mid-West.

For further information, technical data, etc., on any refining process, write

REFINERY PROCESS DIVISION

THE M. W. KELLOGG COMPANY

225 Broadway, New York 7, N. Y.

Also Jersey City, Los Angeles, Tulsa, Houston, Toronto, London and Paris

KELLOGG PULLMAN

LUBRICATE PLUG VALVES

in seconds— instead of minutes

with this timesaving combination

Yes, seconds are all it takes to lubricate plug valves, today. You'll eliminate waste, and save time and effort with this combination: Walworth High Pressure Lubricant Gun, Walworth Button-Head Fittings, and Walworth Jumbo Size Lubricant Sticks. They'll pay for themselves quickly and are adaptable to most of the lubricated plug valves that are in use today.

Walworth High Pressure Lubricant Gun. This is the only gun available today that satisfactorily handles the stick form, full-bodied lubricants needed for proper lubrication and sealing of plug valves. Easy to operate; two Jumbo Size Lubricant Sticks fill the barrel.

Walworth Button-Head Lubricant Fittings. Use them as lubricant fittings or as regular lubricant screws with standard size lubricant sticks. Just slip hose coupling onto fitting for a leakproof connection.

Walworth Jumbo Size Lubricant Sticks. Individually wrapped and packed ten to the box; clean and easy to handle . . . eliminate messy loading. Types available for most line fluids. Always use Walworth Lubricants in Walworth Lubricated Plug Valves.

Start saving today . . . call your nearby Walworth Distributor. He'll be glad to supply Walworth High Pressure Lubricant Guns, Button-Head Fittings, and the right Jumbo Size Lubricant Sticks for any lubricated plug valve service condition.

WALWORTH

Manufacturers since 1842

valves . . . pipe fittings . . . pipe wrenches

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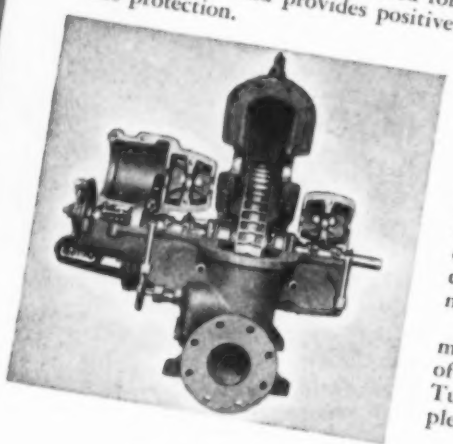
TERRY

PROTECTION OF TURBINE BLADES made possible by nozzle location

The Terry Solid-wheel Turbine is of the impulse, helical flow type. The steam issues from an expanding nozzle at high velocity and enters the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is returned to the wheel several times until practically all of the energy has been utilized. This principle makes possible the efficient use of steam in a single-piece, almost indestructible wheel.

In the Terry Solid-wheel Turbine, the steam enters the buckets in a direction at right angles to the shaft, as shown above. This design eliminates the need for close clearances and provides positive blade protection.



The blades cannot foul. There is a one inch clearance on either side of the wheel. In addition, projecting rims on each side of the buckets prevent damage to the blades even though external thrust should move the wheel.

This is only one of the many important features of the Terry Solid-wheel Turbine. Write for complete details.

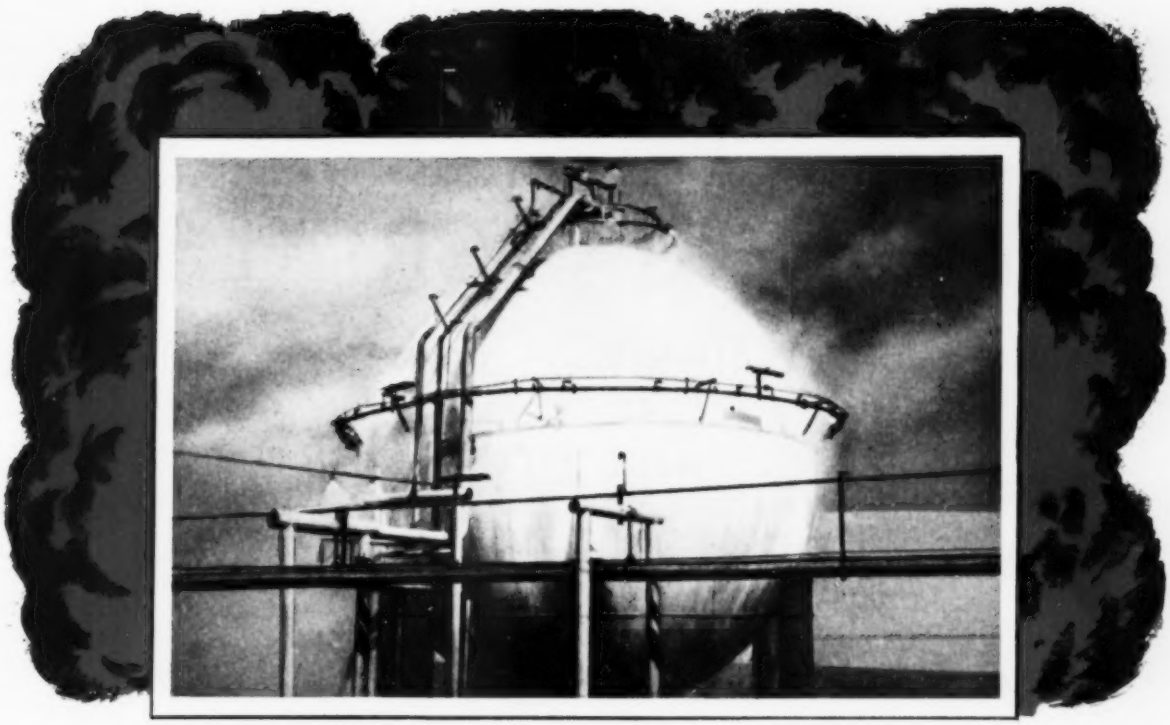
Memo

Send for a copy of bulletin S-116 which describes the many advantages of the Terry Solid-wheel Turbine.

TT-1195

THE TERRY STEAM TURBINE CO.

TERRY SQUARE, HARTFORD 1, CONN.

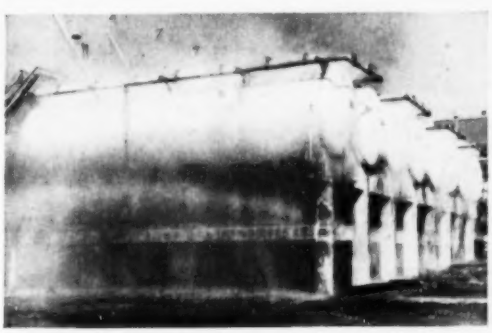


IT CAN'T HAPPEN HERE!

Protection of flammables calls for a system that goes to work the instant fire occurs . . . that's the reason so many tank farms and other hazardous properties are "covered" by

BLAW-KNOX Automatic FOG SYSTEMS

In the event of a critical temperature rise anywhere within the protected area, not a second is lost. A quenching deluge of water-fog smothers the hot spot at once. Other nozzles go into action to cool off adjacent tanks, and alarms are sounded instantaneously. To get the most effective fire protection ask a Blaw-Knox engineer to make a survey of your property and submit an estimate . . . There is no obligation.



Deluge Systems, Wet Pipe Systems, Dry Pipe Systems, Water Spray and Fog Systems, Rate-of-Rise Sprinkler Systems with new improved Spray Heads, Foam and Carbon Dioxide Extinguishing Systems . . . listed by Underwriters Laboratories, Inc. and approved by Factory Mutual Laboratories.

"Little Joey Sprinkler"
Always on the Job

BLAW-KNOX COMPANY
AUTOMATIC SPRINKLER DEPARTMENT
Pittsburgh 33, Pa.
CEdar 1-0700

BLAW-KNOX

Which of these BASIC MATERIALS will solve *your* processing problems?

Norton R electric furnace products are engineered and prescribed to meet many manufacturing needs

Backed by over 50 years of experience in electrochemical refining, Norton brings you basic materials whose purity and properties are carefully controlled and consistently duplicated.

These Norton electric furnace products differ greatly in composition and characteristics. They are the source of the many Norton *engineered prescriptions* which have proved of immense practical value in widely varying processes.

Moreover, each of them has possibilities for use which are still undiscovered. It will pay you, therefore, to read the following descriptions very carefully. Even this partial list may contain the exact combinations of properties *you* need.

ALUMINUM OXIDE (ALUNDUM®)

Norton is the world's largest producer of this basic material — fused alumina. *Characteristics:* high melting point, about 3700°F; specific gravity, 3.95; good chemical stability, neutral to most chemical reagents; extreme hardness of 2000 Knoop, with great toughness; reasonably high thermal conductivity, 2½ times that of fire clay; high dielectric strength. *Uses:* heavy refractory furnace shapes; pure oxide and sintered refractories; radio tube insulation; porous media for filtration and diffusion; catalyst carriers and fluid catalysts; heat exchange pebbles; wear-resistant parts; laboratory ware.

SILICON CARBIDE (CRYSTOLON®)

Silicon carbide is produced by Norton in large tonnages. *Characteristics:* high melting point, disassociates at about 4175°F; specific gravity, 3.20; extreme hardness of 2500 Knoop, with excellent abrasion and erosion resistance; high thermal conductivity, 7 to 10 times that of fire clay; excellent resistance to thermal shock; maintains great strength to very high temperatures (PCE, 3350°F — cone 37 to 40); unique electrical qualities; relatively low thermal expansion; no inversion on heating; chemically acidic, with good stability. *Uses:* special refractories for boiler furnaces, ceramic kiln furniture, heat treating, hearth plates, high thermal conductivity muffles and retorts; electrical heating elements; lightning arrestors; metallurgical additions; also available in a Norton-patented process for coating graphite — in rocket nozzles and reaction motor parts, etc. — for increased resistance to erosion by high velocity gases.

MAGNESIUM OXIDE (MAGNORITE®)

Fused magnesia of highest purity. *Characteristics:* extremely high melting point, about 5,000°F; specific gravity, 3.58; electrical resistivity, 10^8 ohm cm at 1000°C; chemically basic. *Uses:* linings for metal melting furnaces; high temperature electrical insulation; refractories for handling corrosive caustic materials.

FUSED STABILIZED ZIRCONIA

Norton was the first to develop fused zirconia for practical commercial use. *Characteristics:* high melting point; thermal conductivity in British Units at 2000°F is 6.2 for dense shapes, 4.7 for insulating shapes, 2.8 for insulating grain; high resistance to abrasion and thermal shock; not wet by most molten metals; changes from a fairly good electrical insulator at low temperature to a conductor at 1000°C. *Uses:* refractories for extremely high temperatures; setter plates for titanates; furnace linings for high temperature gaseous chemical reactions; zirconium chemicals; metal melting furnace linings; catalyst carriers; heat exchange pebbles; reaction engine parts including jet and rocket liners.

BORON CARBIDE (NORBIDE®)

The hardest man-made material, an exclusive Norton development of boron carbide. *Characteristics:* high melting point, 4440°F; specific gravity, 2.50; compressive strength, 414,000 psi; bending strength, 44,000 psi; self-bonding, unaffected by all acid and alkali solutions. *Uses:* abrasive for economical replacement of diamond dust in lapping; high purity powder of micron sizings for use as refractory and in "cermet" combinations; neutron absorption in nuclear reactors or particle accelerators; pressure-blast nozzles; wearproof bushings, slides, etc.

In these Higgins type arc furnaces tremendous amounts of electrical energy are utilized by Norton in electrochemically refining crude minerals into basic refractory materials.

BORON NITRIDE

Refined by Norton to over 98% purity. *Characteristics:* melts or disassociates at 5400°F; a nonconductor of electricity; weighs only 7 lbs. per cu. ft.; is not oxidized in air at 1200°F. *Uses:* anti-sticking agent for use with molten glass or metal; heat-resistant lubricant; thermal insulator in vacuum or atmosphere furnaces; experimental refractory or crucible material; experimental electrical insulator.

MANY OTHER MATERIALS

Among the high-melting, useful materials made available by Norton are Special Fused Oxides, Refractory Carbides, Refractory Borides, Mixed Borides, Elemental Boron. Research, development and field testing are being conducted on Experimental Borides, Carbides, Nitrides and Silicides. Some of these are in regular industrial use and new uses are being found for others.

AVAILABLE IN MANY STANDARD OR SPECIAL FORMS

Besides supplying these materials in their crude form, more or less as they come from the furnace, Norton has extensive facilities for processing and fabricating — and is ready to work with you in engineering any of these materials to your particular requirements.

GET THIS BASIC MATERIALS BOOKLET

This new Norton Publication, "Basic Materials," contains 22 pages of detailed information, including actual and suggested uses. For your copy, write to NORTON COMPANY, 471 New Bond St., Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.

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Making better products . . . to make other products better

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

THE engineers at National Tube have a big job to do. They're here to solve *your* tubing problems. They excel at their jobs, these engineers, because they are tubing specialists. What's more, they are backed-up by National's "experience file"—a collection of case histories dealing with practically every condition or combination of conditions in the book. These case histories are the result of 60 years' work on tubing problems, and contain the answers to just about every known type of refinery tubing service.

Through this long, varied experience National has improved pipe and tubing to such a degree that we are now able to offer you seamless tubing, condenser tubes, heat exchanger tubes, and refinery piping in a selected group of *24 different analyses*. Each of the 24 analyses has been performance-proved to meet the specific requirements of corrosion and oxidation for which it is recommended. Other chemical compositions are also available in tubular products and a wide variety of high temperature problems are presently under study.

Look over the list of analyses. Then get in touch with us. Our engineers will cooperate in getting the analysis that will insure you utmost efficiency coupled with the most economical performance. Write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

National Tube's 24 different steel tubing analyses:

Carbon	5 Cr, ½ Mo	27 Cr
Carbon, ½ Mo	5 Cr, ½ Mo, 1½ Si	18-8
½ Cr, ½ Mo	7 Cr, ½ Mo	18-8 Ti
1 Cr, ½ Mo	8 Cr, ½ Mo	18-8 Cb
1¼ Cr, ½ Mo	8 Cr, 1 Mo	18-8 Mo
2 Cr, ½ Mo	9 Cr, 1 Mo	25-20
2¼ Cr, 1 Mo	12 Cr	
2½ Cr, ½ Mo, ¾ Si	12 Cr, Al	
3 Cr, 1 Mo	17 Cr	

WALLS WITHOUT WELDS

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)

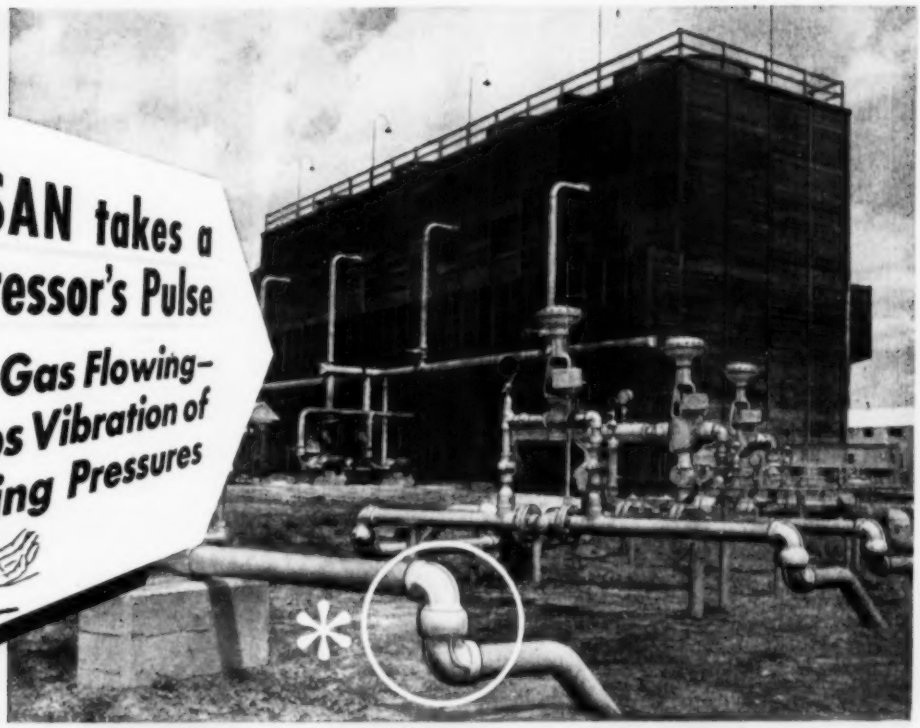
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

U·S·S NATIONAL SEAMLESS PIPE AND TUBES

UNITED STATES STEEL

CHIKSAN takes a Compressor's Pulse

Keeps Gas Flowing—Absorbs Vibration of Changing Pressures



Not only do the stamina and flexibility of Chiksan Joints take expansion in their stride, they absorb pulsation and vibration.

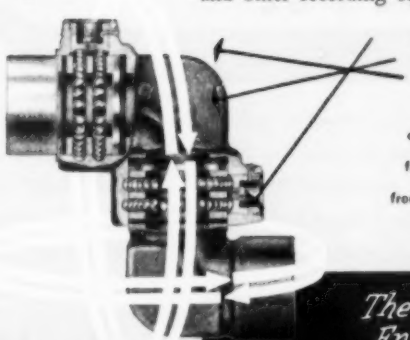
When the Plymouth Oil Company wanted a better way to handle the expansion and contraction of its 2500-3500 lb. natural gas re-pressuring line in its compressor station in Sinton, Texas, back in 1946, it tried Chiksan 2-inch high pressure ball bearing swivel joints. So successful were Chiksan Joints in this application, they were adopted for 3 and 4-inch lines for the same purpose. In addition, by placing regulators, gauges and other recording equipment on a bridge using Chiksan Joints, accurate readings of the instruments could be obtained.

Since 1946, not one of these Chiksan Joints has been replaced or even repacked, and they are giving the same economical, dependable service they did when first installed.

In Texas or California — all over America and all around the world — wherever production, processing or distribution depends on the flow of liquid or gas or on the dependability of hydraulic systems, there you will find Chiksan Ball Bearing Swivel Joints on the job — adding muscle and flexibility — cutting down on shut-downs and maintenance.

Whatever your business, if gas or liquid plays a part, Chiksan's Research and Development Division can help you add efficiency, safety and economy to your operation.

Representatives in Principal Cities
Write for Catalog 53-C, Dept. PR-12



CHIKSAN Ball Bearing Swivel Joints are THE NEW TOOL of Modern Industry — with full 360° rotation in 1, 2, and 3 planes. Over 1,000 different types, styles and sizes have been developed for pressures and services from 28" vacuum to 15,000 psi and for temperature ranges from minus 75° to a plus 500° F. with packing materials for each specific type of service.

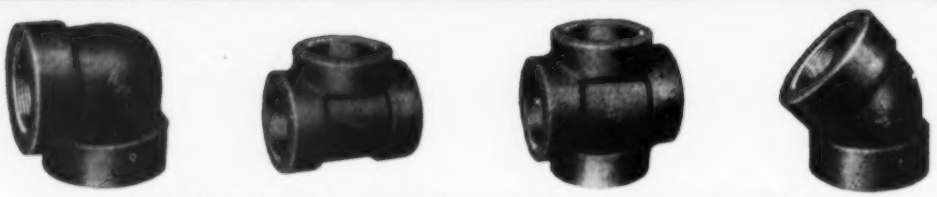
The Flow of Enterprise Relies on **CHIKSAN** *Ball-Bearing Swivel Joints*

CHIKSAN TRADE MARK REG.

CHIKSAN COMPANY • BREA, CALIFORNIA • Chicago 28, Illinois • Newark 2, New Jersey
Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Chiksan Export Company (Subsidiary), Brea, California • Newark 2, N. J.

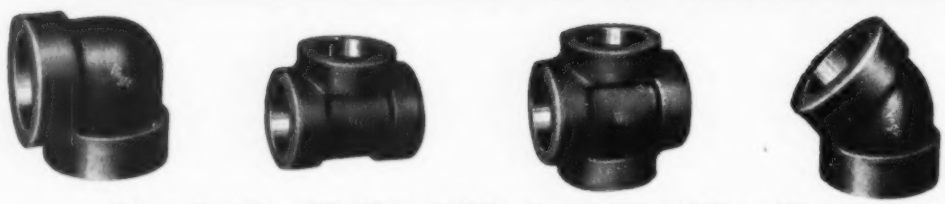
STRENGTH

for Safety and Long-Time Service



For 2000, 3000 and 6000 pounds service — Sizes 1/8" to 6"

SCREW END TYPE



For schedules 40, 80 and 160 pipe — Sizes 1/8" to 4"

SOCKET WELD TYPE

Shocks and stresses imposed by high pressures and high temperatures are taken in their stride because Vogt fittings are uniform in structure, fine grained, and free from porosity . . . the superior product of laboratory controlled materials and giant forging hammers and upsetters. These properties also give higher resistance to erosive and corrosive conditions, thereby adding to service life expectancy in steam plants, petroleum refineries, chemical plants and related industries.

HENRY VOGT MACHINE CO., INC.
Louisville 10, Kentucky
BRANCH OFFICES: NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • DALLAS

DROP FORGED STEEL FITTINGS

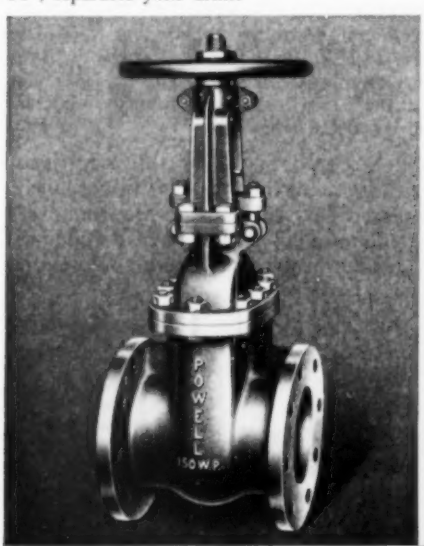
The Finishing Touch

Small details can make a big difference in trimming a tree . . . and in manufacturing valves. For example, *every* Powell Valve part must pass *rigid inspection*. Then, as a final, finishing touch, each Powell Valve is subjected to *actual line tests*.

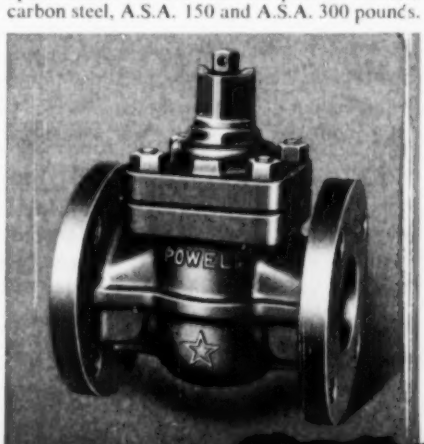
It's these seemingly small details that have helped Powell Valves maintain their record of dependability since 1846. Powell has probably done more valve research, solved more valve problems, and makes more types of valves than any other organization in the world.

With Powell Valves on the job in your plant, you'll say every day's a holiday from flow control worries. Following are just a few of the valves that have the gift of dependable service you want—and need. They're available through distributors in principal cities. If a distributor is not located near you, just write us. We'll be pleased to tell you more about these valves—and our complete line.

STAINLESS STEEL O.S. & Y. GATE VALVE *(Fig. 2453-G)* for 150 pounds W.P. at 500 F. Interchangeable solid or split wedges are precision fitted and accurately guided throughout entire travel. Sizes 2½" to 4", one-piece yoke: 5" to 30", separable yoke arms.



LUBRICATED PLUG VALVE *(Fig. 2201)*. Quarter turn of tapered plug opens and closes valve. Lubricant grooves surrounding parts provide positive seal. Seating surfaces not exposed when open. Semi-steel, 175 and 200 pounds W.O.G.; carbon steel, A.S.A. 150 and A.S.A. 300 pounds.



BRONZE "W.S." FULL FLOW GLOBE VALVE *(Fig. 2608)* for 200 W.P. Stainless steel seat and disc. Nominal pipe size opening through seat permits fuller flow with pressure drop and turbulence cut to minimum.

DEPENDABLE VALVES SINCE 1846

Powell Valves

THE WM. POWELL COMPANY • CINCINNATI 22, OHIO

How a military aircraft problem led to

The Greatest Gasoline Development in 31 Years

TCP* is a revolutionary new gasoline additive that stops the greatest cause of power loss in modern automobile engines. TCP additive is now blended into Shell Premium, and is available at Shell stations throughout the United States.

With the advent of high octane number fuels for peak performance of both military and civil aircraft, the problem of spark plug fouling became critical. Maximum design performance and range of the aircraft were severely limited by deposits formed on the insulating portions of the spark plugs. These deposits caused malfunctioning of the spark plug often at critical times when maximum spark plug performance was necessary. The problem was studied jointly by petroleum suppliers, engine and spark plug manufacturers, and airframe builders both from the chemical and mechanical standpoint.

Shell Research Mobilized

To tackle the problem Shell mobilized its research facilities. First step was development of a dependable test for spark plug fouling. With this test, Shell had the necessary equipment with which hundreds of compounds could be quickly tested—rejected and tested again in different formulations. Round-the-clock testing finally led to the discovery of Shell's TCP additive.

Not since the introduction of tetraethyl lead in 1922 has there been such an important development in gasoline.

How TCP additive helps existing engines—can lead to even better designs

This remarkable ingredient actually changes the nature of combustion deposits inside an engine; actually makes them harmless. Plug-shorting and pre-ignition are eliminated. Now car owners get up to 15% more power—often before using the second tankful. Spark plug life is increased as much as 150%, and gasoline mileage is improved.

Car manufacturers and dealers benefit too! New cars perform the way designers intended; new car buyers have few performance complaints. And for the future, designers can plan for higher compression and horsepower, lighter and more compact engine designs.

TCP is Shell's trademark for this additive. It is another example of the progressive research that goes forward day and night in Shell laboratories. It is evidence again that Shell research provides more and better products from petroleum.

*Patent applied for

SHELL OIL COMPANY

SHELL

Naphtachimie

in production with new **SD** *process*

First

in Europe with Commercial

ETHYLENE OXIDE

by Direct Oxidation

Climaxing 7 years of development, SD's new direct oxidation process for producing ethylene oxide at low cost has now reached successful initial operation . . . at Naphtachimie's new L'Avera plant near Marseille, France, also designed by SD. Naphtachimie is not only first in Europe, but first new producer in the world since 1938 to use such a process. And performance to date, they report, has actually exceeded design specifications. You, too, will profit by utilizing SD's specialized experience in organic chemical plant design. Their services are available to you, on a confidential basis, on any problem involving a process of your own, or one to be procured or developed.

SCIENTIFIC DESIGN COMPANY, INC.

EXECUTIVE OFFICES: 2 PARK AVE., NEW YORK 16, N. Y.

Engineering Offices: Jersey City, New Jersey

WHAT'S NEW AT BRISTOL . . . . WHAT'S NEW AT BRISTOL

Meet the WORLD'S SIMPLEST INSTRUMENT SYSTEM!

It's Bristol's new METAGRAPHIC pneumatic transmission instrument system, for measuring, indicating, recording and controlling pressure, temperature, vacuum, flow, differential pressure and liquid level.

HERE ARE THE BIG ADVANTAGES OF THE NEW METAGRAPHIC SYSTEM:

1. SIMPLICITY – fewer parts, fewer adjustments, and less service required. Range changes can be made in seconds.

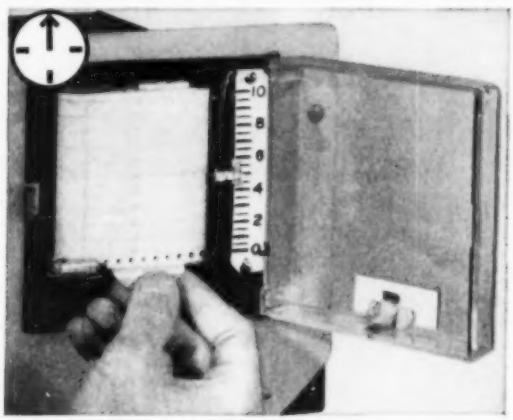
2. FLEXIBILITY – units can be combined like building blocks to make any kind of arrangement.

3. TRUE PLUG-IN SERVICE—results in great savings in installation costs; units can be plugged in or out without stopping process or control.

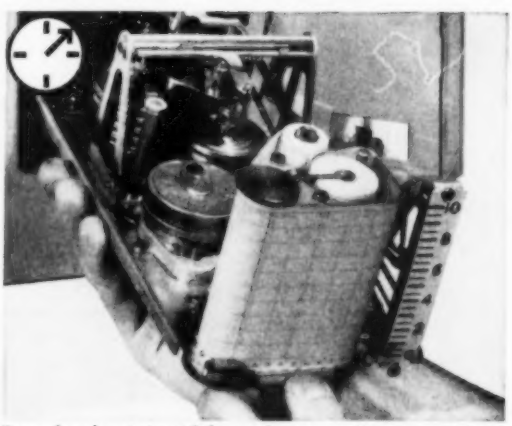
4. NO TIME LAGS—in a four-pipe circuit the transmitter signal and controller-output signal travel around a short loop—as small as three feet.

Get the whole METAGRAPHIC story by writing to The Bristol Company, 111 Bristol Road, Waterbury 20, Conn.

***It takes only fifteen seconds to* change the Bristol METAGRAPHIC recorder to an indicator!**



Case door is opened.



Recorder chassis is withdrawn from case. Air pressure is automatically maintained.

Indicator chassis is plugged into same case.

LOOK FOR OUTSTANDING NEW DEVELOPMENTS FROM BRISTOL

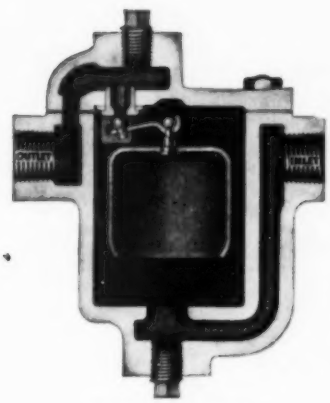
BRISTOL *THE DEPENDABLE GUIDEPOST OF INDUSTRY*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

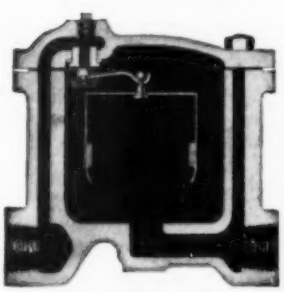
DOUBLE DRAINAGE

AT LOWER COST WITH

Clark DUO-STEP Leverage



CLARK 60-D TRAP



CLARK 70-D TRAP

FAMOUS DUO-STEP LEVERAGE IS NOW AVAILABLE FOR THE FIRST TIME ON THESE SMALLER SIZED STEAM TRAPS. GET HIGHEST DRAINAGE CAPACITY AT LOWEST COST.

Duo-Step is the revolutionary double fulcrum principle that affords maximum leverage to "crack" the valve from the orifice seat, teamed with "Follow-through" power that opens the orifice completely. This double action actually gives you double the drainage capacity of ordinary steam traps.

MODEL 60-D traps are of cast semi-steel construction, designed for pressures up to 200 P. S. I. and temperatures to 400° F. Duo-Step levers and brackets of stainless steel construction. Seats and discs are of Clark-loy. ½" or ¾" horizontal inlet and outlet connections with ¼" test outlet and drain plug. Vertical inlet can be furnished in ½" or ¾" size.

MODEL 70-D traps are of cast semi-steel construction, designed for pressures up to 200 P. S. I. and temperatures to 400° F. All working parts of stainless steel construction. Seats and discs are of Clark-loy Horizontal inlet and outlet connections located at bottom of trap body for close-to-the-floor installations.

MODEL 70-TD for pressures to 150 P. S. I. and temperatures to 375° F. is available WITH BUILT-IN THERMAL BY-PASS at additional cost.

FOR COMPLETE INFORMATION CONTACT YOUR CLARK REPRESENTATIVE OR WRITE FOR *NEW* DUO-STEP BROCHURE

THE HOME OF DUO-STEP LEVERAGE

Clark

MANUFACTURING COMPANY

1830 EAST 38th STREET

CLEVELAND 14, OHIO

Distributors and Representatives in all major cities

Tenamene 1
Tenamene 2

most effective gum inhibitors known

Tenamene gum inhibitors have set the standards of the industry for over 15 years. No known inhibitors are more effective in preventing gum formation.

They're economical too. For example, as little as 5 pounds of Tenamene 1 may be needed to treat 1000 barrels of gasoline—at a cost of approximately 2½¢ per barrel.

The use of Tenamene 2 results in an extra dividend for refiners. It can be used as a combination sweetening and inhibiting agent to save time, materials and equipment.

Send for the Tenamene booklets listed in the coupon. They contain interesting general information about gum inhibiting and sweetening as well as specific data about the Tenamenes. Our Petroleum Chemicals Laboratory will be glad to make tests and recommendations on any of your inhibiting or sweetening problems.

SALES OFFICES: Eastman Chemical Products, Inc., Kingsport, Tenn.; New York—260 Madison Ave.; Framingham, Mass.—65 Concord St.; Cleveland—Terminal Tower Bldg.; Chicago—360 N. Michigan Ave.; St. Louis—Continental Bldg.; Houston—412 Main St. **West Coast: Wilson Meyer Co.,** San Francisco—333 Montgomery St.; Los Angeles—4800 District Blvd.; Portland—520 S. W. Sixth Ave.; Seattle—821 Second Ave.

Tenamene EASTMAN GASOLINE ADDITIVES

Eastman
CHEMICAL PRODUCTS, INC.

Eastman Chemical Products, Inc., Chemical Sales Division, Kingsport, Tenn.

Gentlemen: Send me copies of your booklets: "Inhibiting Motor Fuels with the Tenamenes" and "Tenamene 2 Inhibitor Sweetening."

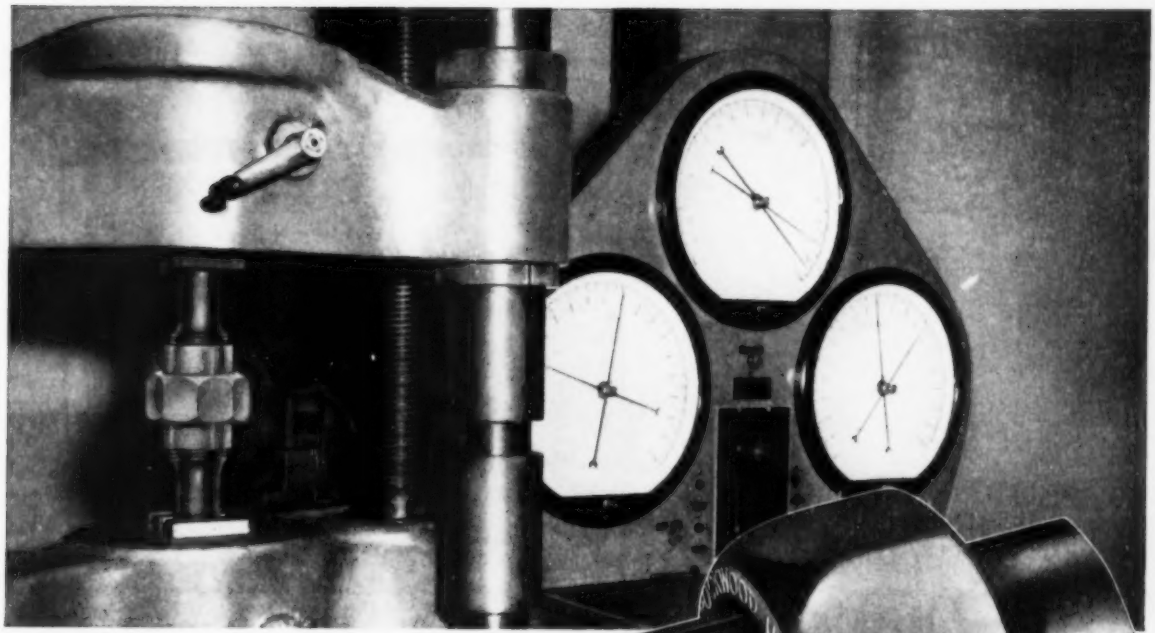
NAME & TITLE .....

COMPANY .....

STREET .....

CITY & STATE .....

Sales Representative for **TENNESSEE EASTMAN COMPANY,** Kingsport, Tennessee, division of **EASTMAN KODAK COMPANY.**



Higher Resistance to tough working conditions (expansion and contraction — shock, jar and vibration) is assured by constant testing of Rockwood Unions' tensile strength.

Tests prove

2-inch Rockwood Unions withstand average breaking loads of 82,000 pounds

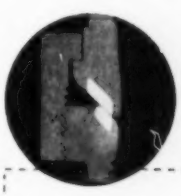
Removed regularly from production for testing, Rockwood Unions prove strong under pressure.

The one-inch size withstands average breaking loads of 46,000 pounds, the two-inch 82,000 pounds. What's more, this strength is evenly distributed. Over-all balanced design makes all three parts equally rugged.

Remember, too, you get these additional features —

- Seats double-locked in place under 100,000 and 400,000 pound pressures
- Cold-forged seat joints made of non-corrosive stainless steel or Moly 341
- Plug-type, ball-to-cone construction makes piping alignment quick and easy, eliminates sharp corners and edges that scratch or damage
- "Rockwoodizing" — a special coating process — protects every Union against corrosion
- Absolute interchangeability of parts makes possible speedy replacements

Special Non-Corrosive Seats are a Rockwood Union feature. Specify Rockwood Type 602 Union with two stainless steel seats — or Rockwood Type 603 Union with two Moly 341 seats. Rockwood Unions are tested and listed by Underwriters' Laboratories, Inc., for use in handling flammable liquids and gases.



ROCKWOOD
SPRINKLER COMPANY
MANUFACTURERS OF THE MOST COMPLETE LINE OF STEEL UNIONS ON THE MARKET
Worcester 5, Massachusetts

ROCKWOOD SPRINKLER COMPANY
102 Harlow Street
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Please send me further information on Rockwood cold-forged Steel Unions.

Name_____

Title_____

Company_____

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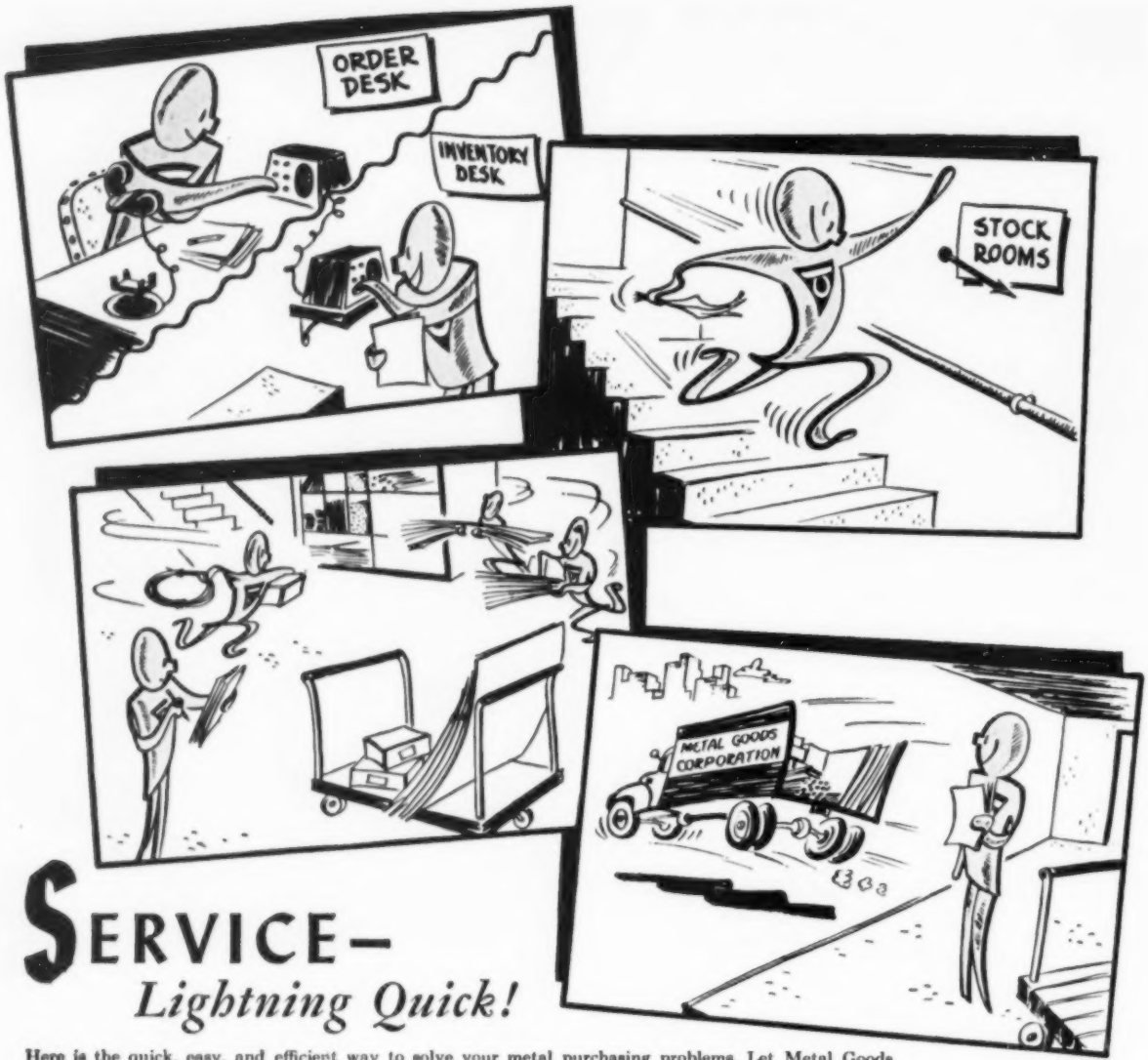
City_____ Zone____ State_____



SERVICE—
Lightning Quick!

Here is the quick, easy, and efficient way to solve your metal purchasing problems. Let Metal Goods Corporation supply all your metal needs.

One call . . . one requisition . . . one invoice . . . that's the modern, time-saving, cost-cutting way to buy metals. When you want aluminum, brass, copper, monel*, nickel*, inconel*, stainless steel, and steel—make one call to Metal Goods Corporation.

**Not sold in St. Louis or Kansas City*

7 warehouses and 11 Sales Service offices to serve you. Call your nearest office.

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W. P. Crowley, Jr.
Phone: 4-9923

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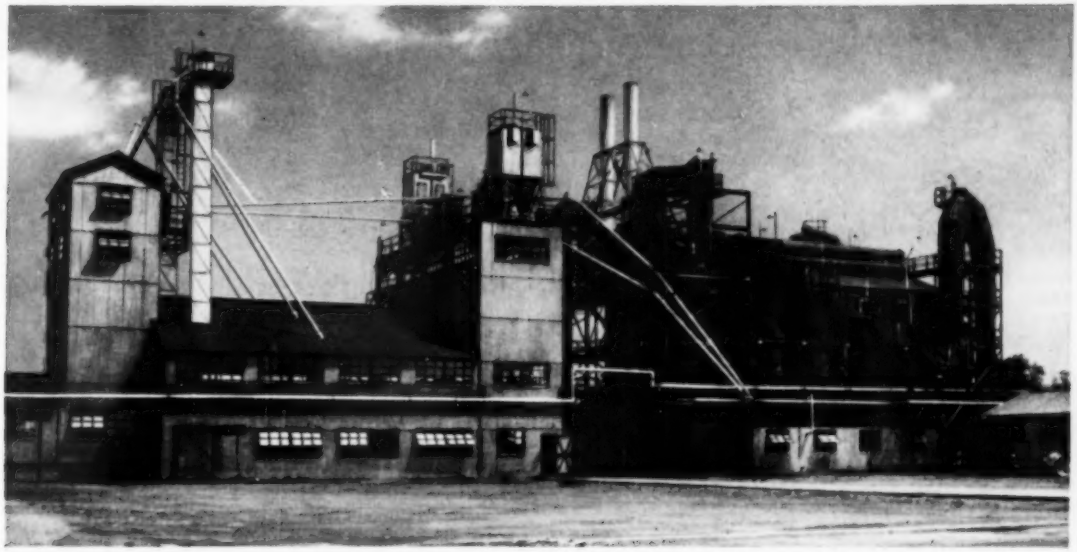


NEW INDUSTRY *for Canada*

The Furnace Carbon Black plant of Cabot Carbon of Canada Ltd. is Canada's first oil furnace carbon black plant.

The principal process equipment was designed by Cabot Engineering Company of Pampa, Texas, affiliates of Cabot Carbon of Canada, Ltd. Stone & Webster Canada Limited, with the assistance of Stone & Webster Engineering Corporation, furnished consulting services and constructed the plant.

STONE & WEBSTER ENGINEERING CORPORATION

Affiliated with **STONE & WEBSTER CANADA LIMITED**

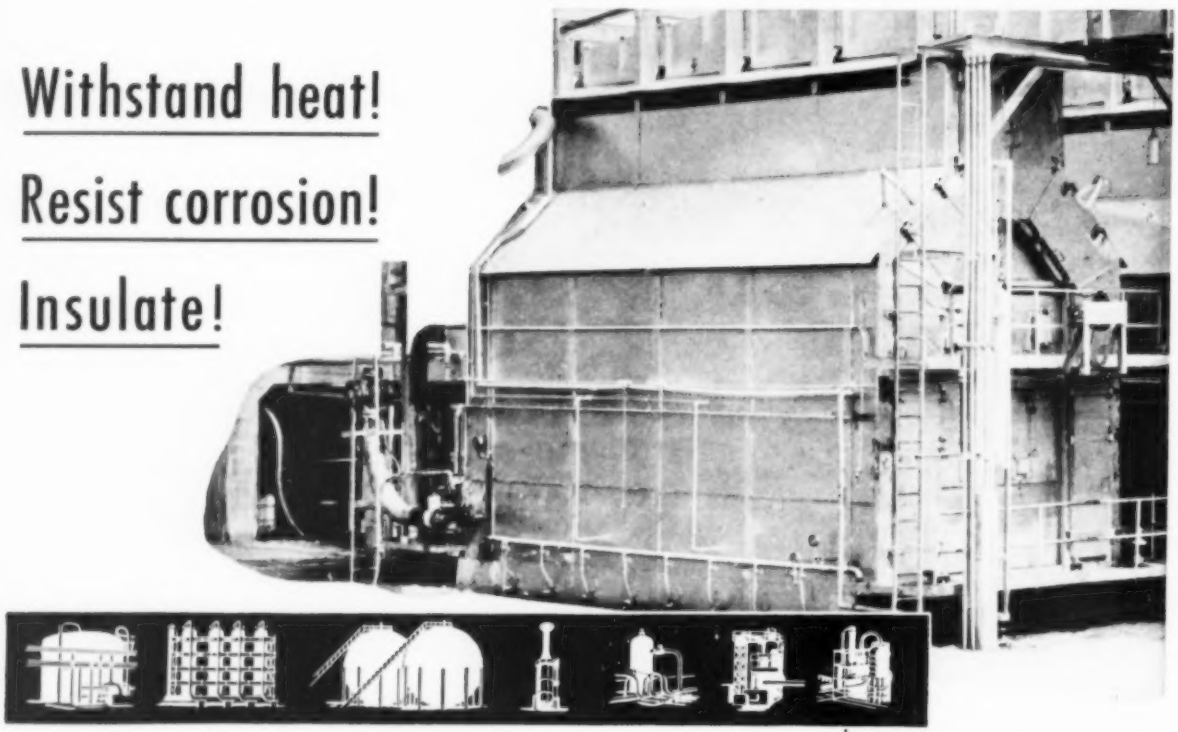
Cabot Carbon of Canada Ltd.'s new plant at Sarnia, Ontario, supplies high abrasion furnace black and fast extruding furnace carbon black for Canadian-made tires and other rubber goods.

SPECIAL INDUSTRIAL CONCRETES

Withstand heat!

Resist corrosion!

Insulate!



HEATER PANELED IN CONCRETE—Low-cost, long-service construction of this 26' Universal Oil Products cracking-unit heater utilizes panels cast with economical refractory concrete—one of the special industrial concretes you can make with Lumnite Cement.

Yes—there *are* concretes that will do all three jobs, and save money at the same time! Special industrial concretes made with Lumnite* calcium-aluminate cement offer all the placing convenience of normal concrete mixtures *plus* an unusual combination of heat and corrosion resistance and insulation.

For instance, using Lumnite Cement with suitable aggregates produces concretes that withstand soaking heat or temperatures up to 2700°F. Provides high insulating efficiency, too, if needed. And the chemical composition of Lumnite Cement makes all these concretes highly resistant to the attack of sour crude and sulphur vapors.

Performance like this means that you can save throughout the refinery with fast, economical concrete construction. Down time is cut to a minimum, because special industrial concretes are quickly placed by cement "gun," trowel or pouring. And they reach service strength in 24 hours or less!

For convenience you may prefer to make these special industrial concretes with prepared castables (Lumnite Cement plus aggregates selected for specific temperature and insulation service—add only water.) They're made by refractory manufacturers and sold through their dealers. For more information write Universal Atlas Cement Company (United States Steel Corporation Subsidiary), 100 Park Avenue, New York 17, N.Y.

WHERE TO USE SPECIAL INDUSTRIAL CONCRETES:

- **Tank linings and pipe linings for protection from sour crude.**
- **Linings of reaction and reforming chambers; fractionating, cracking, rerun, distillation, vaporizing, and alkalization units; bubble, stripper and flash towers; accumulators and soakers.**
- **In furnaces, heaters and coking ovens.**
- **In ducts, furnace foundations, floors subject to soaking heat.**
- **Stack and flue linings.**

**"LUMNITE" is the registered trade-mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.*

FR L-7-48

ATLAS® **LUMNITE for INDUSTRIAL CONCRETES**

REFRACTORY, INSULATING, OVERNIGHT, CORROSION-RESISTANT

A UNIVERSAL ATLAS PRODUCT

UNITED STATES STEEL HOUR—Televised alternate weeks—Consult your newspaper for date, time and station.

Taylor Mercury Manometer gives you continuous ranges from 10" to 533" of water!

AND no piping changes are necessary when changing from one range to another, because there are six interchangeable range tubes (10", 20", 50", 100", 200" and 400" of water). All except 10" range may be over or under-ranged 33⅓%. Instrument has pressure connections both at side and top of manometer; a union coupling prevents distortion of bearing housing... eliminates binding or friction caused by wrench torque; when necessary for recording two Flows or for Ratio-Flow control two manometers can be mounted on the back of a single case.

NOTE THESE ADDITIONAL FEATURES:

Great power—thanks to extra big float with extra long travel. Microfinished shaft with Teflon bearings "float" this power right through to the pen.

High accuracy—inherent straight line calibration.

Positive actuation—high energy output. Big 3 5/16" float. Long float travel—1". Simple lever system. Teflon in pressure-tight bearing surfaces for efficient use of power. Jewelled thrust bearing.

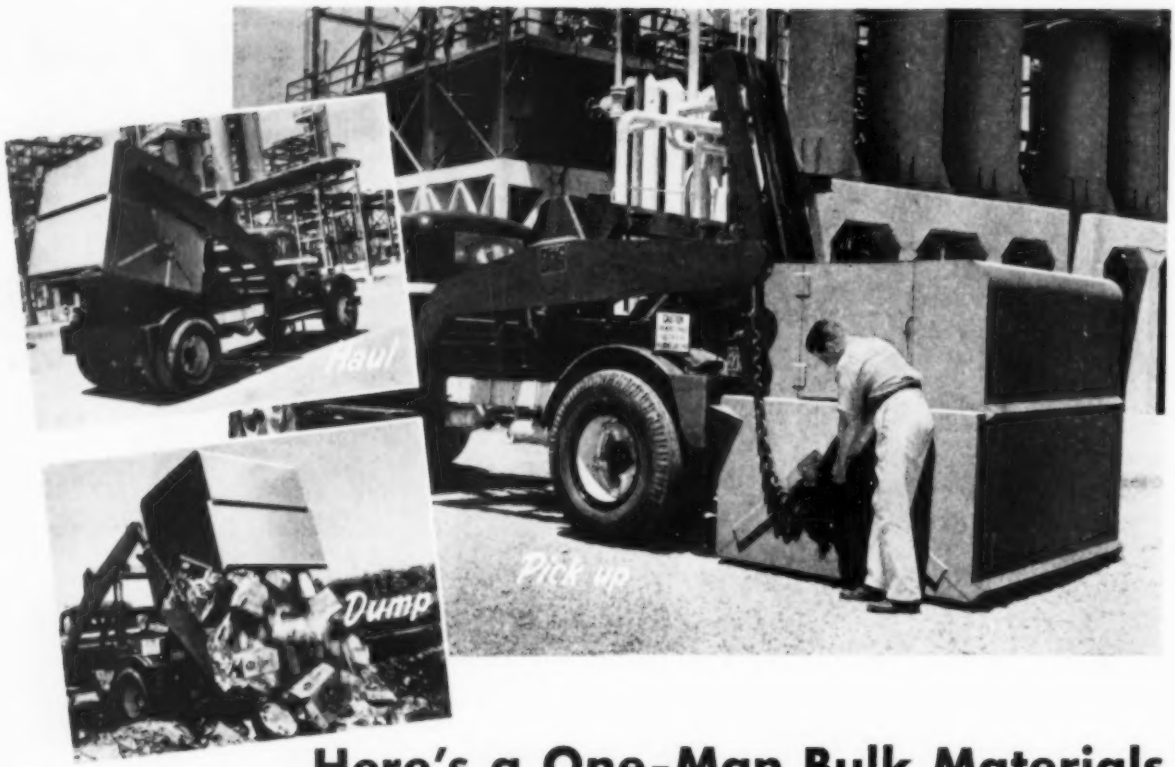
Dependable performance—submerged check valves give positive shut-off. Unique damping valve adjustable under full pressure without leakage. Ample room in mercury chambers to accommodate surges or pulsating flows. Teflon holds pressure, yet lets shaft turn freely, giving long service.

Ease of maintenance—low pressure chamber cover permits easy access to float and lever arm during calibration. Entire pressure tight bearing easily and economically replaced.

Ask your Taylor Field Engineer, or write for **Bulletin 98182.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY



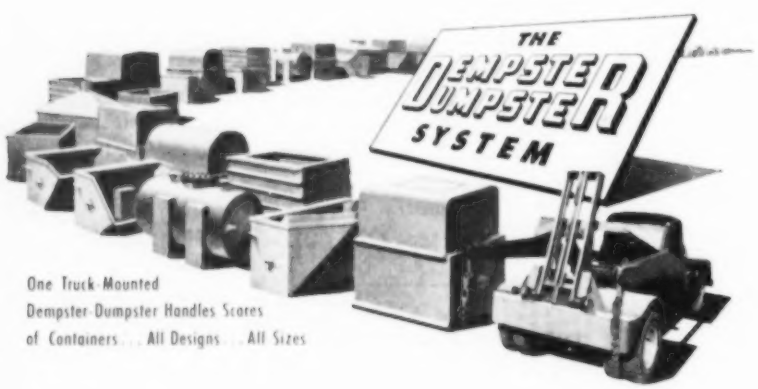
Here's a One-Man Bulk Materials Handling System for Your Plant...

In the Dempster-Dumpster System of bulk materials handling only one man, the driver of the truck-mounted Dempster-Dumpster, is required for operation. The Dempster-Dumpster serves scores of detachable Dempster-Dumpster Containers. Container capacities range up to 4 times that of conventional dump truck bodies and each container is designed to suit the materials to be handled—be they solids, liquids or dust . . . hot or cold . . . bulky, light or heavy. You simply place these containers at convenient materials accumulation points inside or outside buildings. When loaded each container is picked up, hauled and emptied (as shown above) or load set down intact. Entire operation is handled by hydraulic controls in cab.

Containers shown below are just a few of the many available or that can be built to meet your needs. They enable you to handle, at tremendous savings, materials of many descriptions—trash and waste materials, raw materials, finished products, etc. —with only one truck and only one man, the driver.

Without question, the Dempster-Dumpster System is the most economical and most efficient method of plant materials handling by truck ever devised!

Write to us for complete information. Manufactured exclusively by Dempster Brothers, Inc.



One Truck-Mounted
Dempster-Dumpster Handles Scores
of Containers . . . All Designs . . . All Sizes

DEMPSTER BROTHERS, 5123 Dempster Bldg., Knoxville 17, Tennessee

FROM THE GHOSTS OF THE PAST . . . SPRING THE COMPANIES OF THE FUTURE!

Announcing a **NEW** Advertising Series

"THE BRAND OF PROGRESS"

By Heat Exchanger Specialists

▲ It was 1909 when the photographer squeezed the bulb on his camera and film-recorded the top photograph. Western Supply Company, a small machine shop engaged in the repair of cable-drilling tools, had been in business for three years. At that time there were no gleaming rails to the South of the infant company and machinery was delivered by buckboard over muddy, rutted streets.

But both the Southwest and Western Supply expanded as the vast oil fields of the area were discovered and opened for production. This expansion gave birth to the vital need for machines and craftsmen to manufacture refinery equipment for processing the new-found oil. It was this condition in 1936 which channeled Western's facilities toward the manufacture of heat transfer equipment.

Today, Western is counted as one of the primary manufacturers of all types of heat exchangers. The big Western "W" can be seen in the largest plants of the Petroleum, Chemical and Petro-Chemical industries — ample testimony to Western's ability to keep pace with these rapidly expanding fields.

An advertising series titled, "The Brand of Progress" will present the reasons behind the growth of Western Supply Company. Follow this series in this magazine.

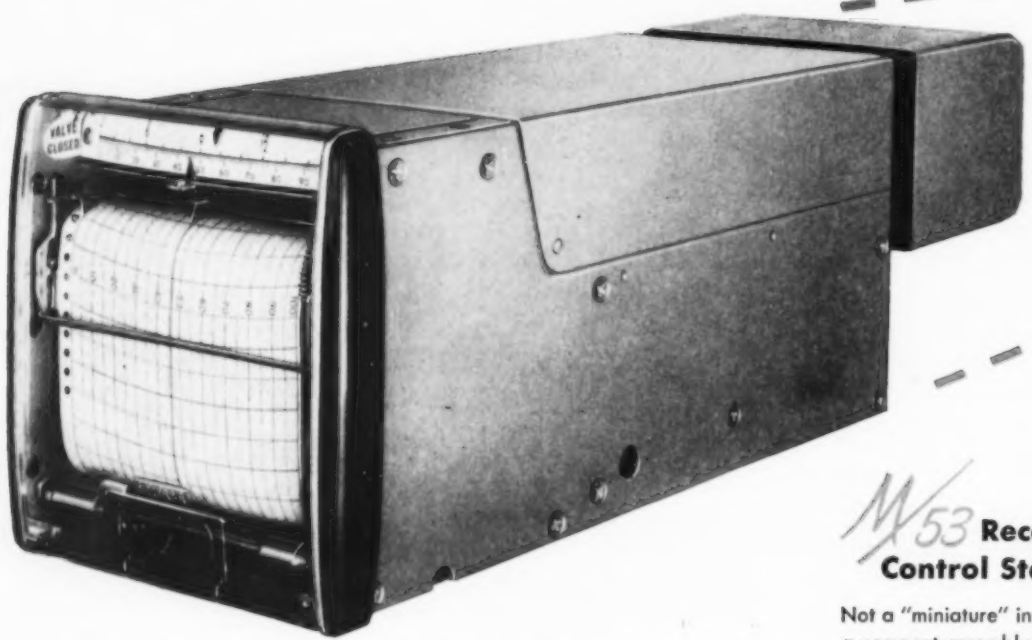
WESTERN
HEAT EXCHANGERS

TEMA

Manufactured by
WESTERN SUPPLY COMPANY
P.O. BOX 1888 TULSA, OKLAHOMA

This exclusive Foxboro

outperforms any other Automatic Controller!



M/53 Recording Control Station

Not a "miniature" instrument, but a compact assembly of full-size component parts with no compromise in accuracy or convenience. *Features:* continuous valve position indicator . . . fast, no-drift control point setting plus micrometer adjustment . . . no external knobs . . . full 4" width, 30-day, easy-loading chart . . . several months' ink supply . . . single-switch automatic-manual transfer . . . additional measurement pen optional.

If you think this claim is exaggerated, just put a Foxboro M/58 Consotrol* Controller with M/53 Recorder on your process. The tougher the job, the more it will outperform other controllers!

Or ask any present user . . . many of the largest, most progressive petroleum and chemical processors are using hundreds of these instruments. They will unhesitatingly confirm that this Foxboro component system has put their processes "on stream", automatically and smoothly from the control room, without false starts or confusion.

This Consotrol Controller-Recorder system is an entirely different and original concept of instrumentation, developed through knowledge gained in Foxboro's 30 years of control leadership. The exclusive floating disc live-balance controller, and the full size 4"-chart recorder, are combined in an ultra-compact yet fully accessible 6" x 6" assembly. The result is unequalled ease of operation, repeatability of action, and uniform product quality.

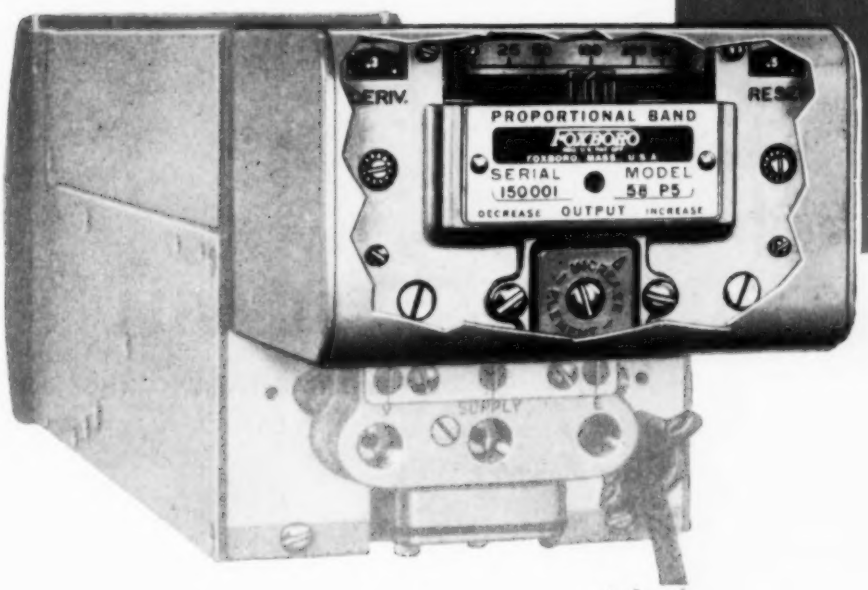
Get complete facts on this remarkable advance in automatic control. Write for Bulletin 463, and ask your Foxboro representative for a demonstration.

*Reg. U. S. Pat. Off.

THE FOXBORO COMPANY, 7412 NEPONSET AVE., FOXBORO, MASS., U. S. A.

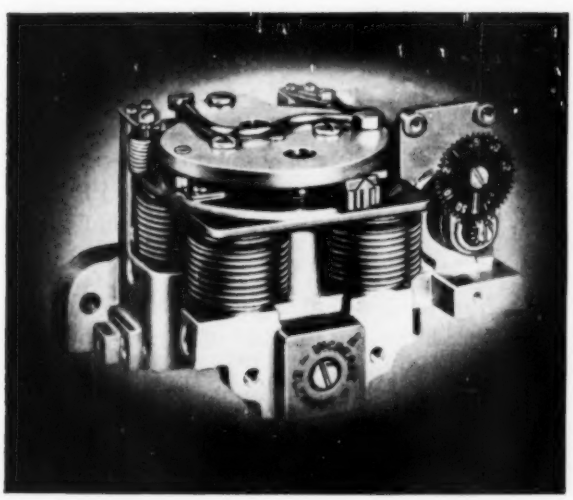
FOXBORO
REG. U. S. PAT. OFF.

development



M/58 Controller

A remarkable design achievement, embodying the precision, sensitivity, and "live balance" of the exclusive floating disc. *Features:* no diaphragms . . . only one nozzle . . . only 19 parts . . . all four control functions available, including two ranges of reset . . . plug-in reset and derivative units. Can be integrally mounted with the M/53 as shown, or remotely located.



Revolutionary Design

Here's the high-precision Foxboro "floating disc" balancing system. Matched bellows provide stability and simplicity unapproached by other designs. Plug-in reset unit shown at right of assembly; derivative unit similarly plugs in at left. The lever-set proportional band adjustment is calibrated to 500%. This flexibility of function makes the M/58 adaptable to any process.

FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

CONSOTROL INSTRUMENTS

Call your shots

Specify **SCOVILL** PHOSPHORIZED

ADMIRALTY HEAT EXCHANGER TUBES

When you are up against tough operating conditions affecting heat exchanger tubes...relax. Accept our invitation to let Scovill engineers help work out the right tube specification. Then go ahead and call your shots on performance.

Any one of Scovill's popular heat exchanger tube alloys will prove best in its class for specified service conditions. Most popular of them all is our Phosphorized Admiralty Tube . . . *in a class by itself* because it is hot extruded from CONTINUOUS-CAST billets. Scovill Continuous Casting of this alloy assures highest standards of SOUNDNESS and UNIFORMITY, and optimum amount of inhibitor (Phosphorus) for maximum resistance to dezincification. Tube troubles literally find no "foothold" in uniformly protected and finished tube surfaces.

Our informative 40-page heat exchanger tube technical booklet will be sent on request. Inquiry outlining your problems and needs is welcomed. Write Scovill Manufacturing Company, 99 Mill Street, Waterbury 20, Conn. Phone Waterbury 4-1171.

SCOVILL
HEAT EXCHANGER TUBE ALLOYS

- PHOSPHORIZED ADMIRALTY
- ADMIRALTY
- ARSENICAL ADMIRALTY
- MUNTZ METAL
- NAVAL BRASS
- RED BRASS, 85%
- DEOXIDIZED COPPER
- ARSENICAL COPPER
- COPPER NICKEL, 10% & 20%
- CUPRO-NICKEL, 30%
- CUPRO-NICKEL, 30% (High Iron)
- ALUMINUM BRASS
- ALUMINUM BRONZE, 5%
- DUPLEX TUBE

SCOVILL

"You can't buy better Brass"

05C53

Good water at lowest cost

Layne can help you get it

For 70 years Layne has been planning and producing efficient, economical, dependable water supply systems for municipalities, industries and farms. Layne perfected the gravel wall well. The Layne factory has produced a superior vertical turbine pump and well screen. New methods and materials are constantly being developed and proven in the laboratories of the Layne Research Division, the only organization of its kind in the world.

Undivided responsibility

When you let Layne develop or increase your water supply you save money because Layne does the whole job. From initial surveys and test drillings to completed water system and maintenance service through the years you deal with only one organization. Layne gives you dependable, economical, undivided responsibility.

World-wide experience

Our world-wide experience can be of benefit to you . . . in developing a new water supply . . . in extending your present system . . . in achieving greater production through overhaul of your existing system.

Consult your nearest Layne Associate Company or write Layne & Bowler, Inc., Memphis 8, Tenn.

Layne

Water Wells

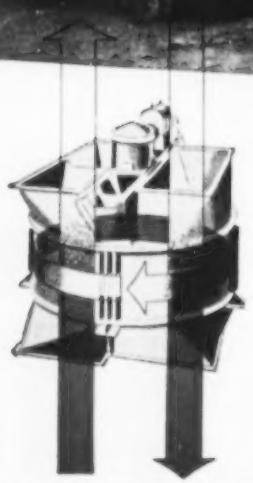
Vertical Turbine Pumps

Water Treatment

Layne Associate Companies Throughout The World

Get Higher Throughput with a

Ljungstrom Air Preheater



The Ljungstrom operates on the continuous regenerative counter-flow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.

With the process industries' production at all-time high levels – and climbing higher – here is a timely suggestion that may point the way to significant production increases in your plant – *without adding a single still.*

A Ljungstrom Air Preheater, properly combined with modern draft and burner equipment, can increase still production as much as 25%. At the same time, plugging is so much reduced that production lost to downtime will be astonishingly low.

The value of the Ljungstrom Air Preheater lies in its ability to recover heat normally lost up the stack, and to return a large portion of it to the furnace zone in the form of preheated combustion air. Fuel requirements are drastically reduced and–where furnace capacity permits – throughput goes up considerably.

Furthermore – the finer temperature control possible leads to closer control of the end product. This alone can mean tens of thousands of dollars a year.

Wherever you are replacing, modernizing, or adding new equipment that burns fuel – consider the economies you can get with a Ljungstrom. Call or write The Air Preheater Corporation for complete information.

Wherever You Burn Fuel, You Need Ljungstrom

THE AIR PREHEATER CORPORATION 60 East 42nd Street, New York 17, N. Y.

In 1940, the Petro-Chem Development Company lined their first Iso-Flow furnace with B&W Insulating Firebrick. Today, over 1200 installations later, (some with fluid outlet temperatures over 1600F) not a single furnace has ever been shut down because of the need for refractory maintenance.

Long life is just one reason furnace builders, as well as furnace operators, insist on B&W IFB. Here are four more:

CUT INSTALLATION COSTS

B&W Insulating Firebrick are easy to install. They can be cut, drilled or shaped on the job with ordinary woodworking tools. Their lightness makes them easy to handle.

ELIMINATE EXPENSIVE ALLOYS

Because of their high insulating values, B&W Insulating Firebrick can be supported or anchored with ordinary carbon steel. Expensive, heat-resisting alloys are not necessary.

REDUCE DOWN-TIME

These brick have low heat storage, cool off quickly. This makes possible quick access to the furnace for inspection. They heat up quickly to get back on the line, too.

CLOSE TEMPERATURE CONTROL

Due to the low heat-storage capacity of B&W IFB, their hot-face temperature responds quickly to changes in the rate of heat input to the furnace — insuring the closest possible temperature control.

You, too, can profit by this four-way economy of B&W Insulating Firebrick. Ask your B&W representative for all the facts on these cost-cutting refractories. He'll be glad to discuss your refractory problems with you.

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

B&W REFRACTORIES PRODUCTS — B&W Allmul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick • B&W Insulating Firebrick B&W Refractory Castables, Plastics and Mortars • OTHER B&W PRODUCTS — Stationary & Marine Boilers and Component Equipment... Chemical Recovery Units . . . Seamless & Welded Tubes . . . Pulverizers . . . Fuel Burning Equipment . . . Pressure Vessels . . . Alloy Castings

Building a new Ethylene Plant

Shown here in its final stages of construction, National Petro-Chemicals Corporation's new ethylene plant at Tuscola, Illinois is the largest in the world—the tenth ethylene plant which Lummus has designed and built.

Perhaps our experience in designing, engineering and building petrochemical and chemical plants can be of use on your next project.

LUMMUS ®

THE LUMMUS COMPANY

385 MADISON AVENUE, NEW YORK 17, N. Y.

HOUSTON • CHICAGO • LONDON • PARIS • CARACAS

DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

. . . another place where REPUBLIC

ELECTRUNITE PRESSURE TUBES

DO THE JOB BEST . . .

When you take heat exchangers off-stream for retubing, make sure you increase the time between retubings . . . install Republic ELECTRUNITE Pressure Tubes.

You have your choice of carbon steel tubes and several analyses of ENDURO Stainless Steel tubes . . . all made by the ELECTRUNITE process which assures uniformly round tubes inside and out, uniform wall thicknesses and uniform bending and expanding characteristics.

And you needn't wait until retubing to get the long-lasting benefits of Republic ELECTRUNITE Tubes . . . leading manufacturers of heat exchanger equipment know and use these time-proven tubes for many *new* condensers and heat exchangers.

Write for Booklet giving specifications and design data on Republic ELECTRUNITE Boiler, Condenser and Heat Exchanger Tubes.

STEEL AND TUBES DIVISION
REPUBLIC STEEL CORPORATION
220 EAST 131st STREET • CLEVELAND 8, OHIO

ELECTRUNITE—The Original Electric Welded Boiler Tube

Republic
ELECTRUNITE
BOILER, CONDENSER AND HEAT EXCHANGER TUBES

REPUBLIC STEEL

the last
CLARK
OLEAN, NEW YORK, U.S.A.
November
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1953

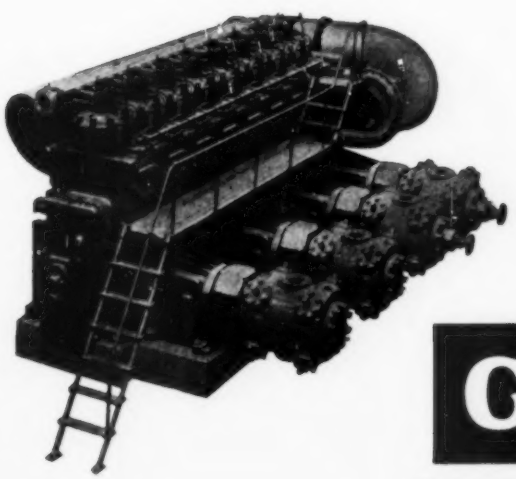
one's FREE

Guaranteed to burn less fuel than *any* Compressor now built, Clark Turbocharged 2-Cycle Gas-Engine-Driven Compressors assure a saving of 12½% in fuel costs over non-turbocharged units of comparable displacement. In figuring fuel bills, you can cross off the last month of your calendar . . . actually, the last 45 days.

This is only one of the savings you'll realize. Increased power, decreased water cooling load and lower manpower requirements for a given station size are among the other major economies of the new Clark TRA and TLA turbocharged units. Sizes range from 825 to 3,300 bhp.

Get complete details by writing for Bulletin 130 or contact your nearest Clark representative.

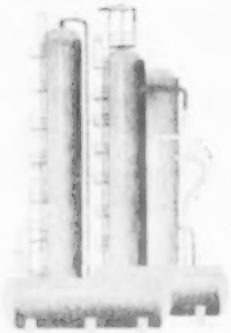
CLARK BROS. CO., OLEAN, N. Y.
Division of Dresser Operations, Inc.
Sales Offices in Principal Cities Throughout the World



CLARK
compressors

Clark continues to set the pace in compressor progress

ADVANTAGES NOT RESTRICTED BY SIZE



SELAS
Gradiation®
HEATERS

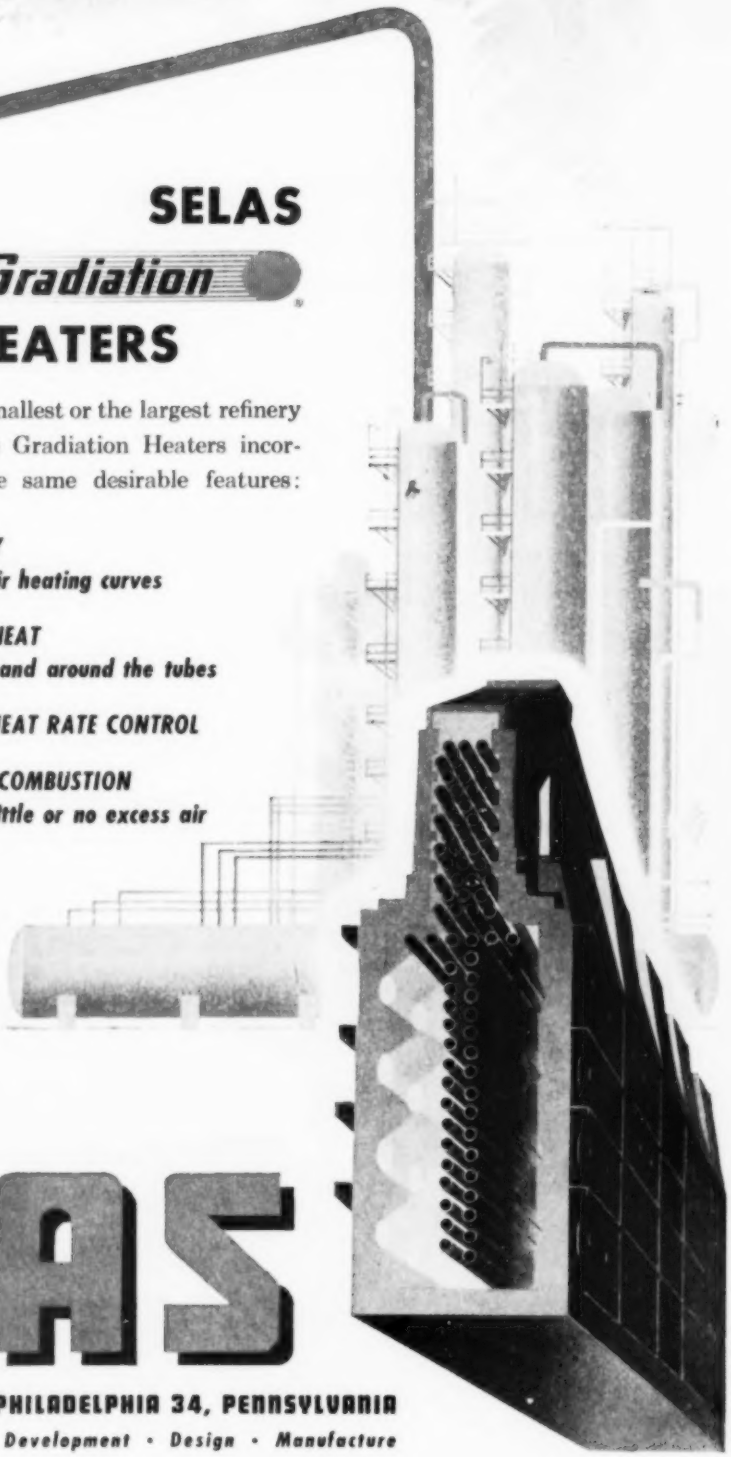
For the smallest or the largest refinery unit Selas Gradiation Heaters incorporate the same desirable features:

FLEXIBILITY
in their heating curves

UNIFORM HEAT
along and around the tubes

POSITIVE HEAT RATE CONTROL

COMPLETE COMBUSTION
with little or no excess air



SELAS

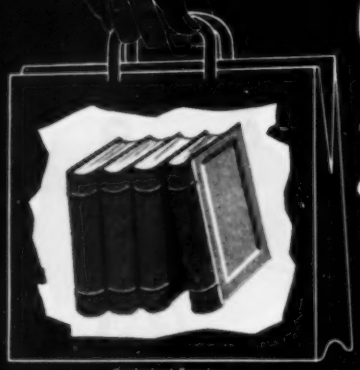
SELAS

CORPORATION OF AMERICA • PHILADELPHIA 34, PENNSYLVANIA

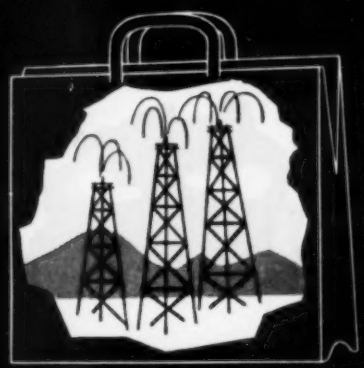
Heat Processing Engineers for Industry • Development • Design • Manufacture

CYANAMID SERVICE

. . . integrated to meet your chemical requirements—now and in the future



Technical Service



AEROPAN Drilling Mud Conditioner

Gelling Agents

AEROLUBE Lubricating Oil Additives

The extent of Cyanamid's service to the petroleum industry is well illustrated by the wide range of Cyanamid Chemicals—from drilling mud conditioners to lube oil additives.

Cyanamid Service, however, is more than chemicals. It is constant research . . . extensive manufacturing facilities . . . and a skilled staff of technical field specialists—all carefully integrated to meet chemical requirements in every phase of production and refining.

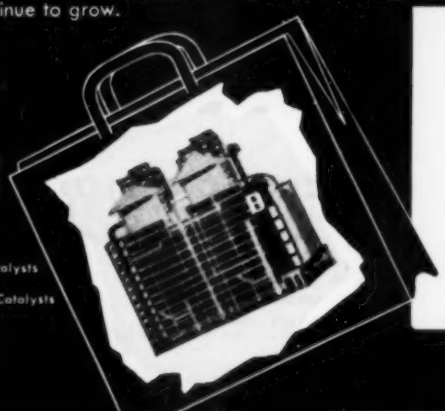
Cyanamid Service, too, is a continuing program of plant expansion designed to keep pace with the petroleum industry's rapid growth. Results of this program have been milestones in petroleum progress. In the field of synthetic catalysts, for example:

1942 . . . Cyanamid starts production of synthetic fluid cracking catalysts at Fort Worth, Texas, to help refiners meet demand for high octane fuel.

1946 . . . Cyanamid becomes the first company to manufacture microspheroidal cracking catalysts on a commercial scale.

1951 . . . Cyanamid builds new MS plant at Michigan City, Indiana, as refining demands continue to grow.

Specialty Catalysts



AEROFORM MS Fluid Hydroforming Catalysts

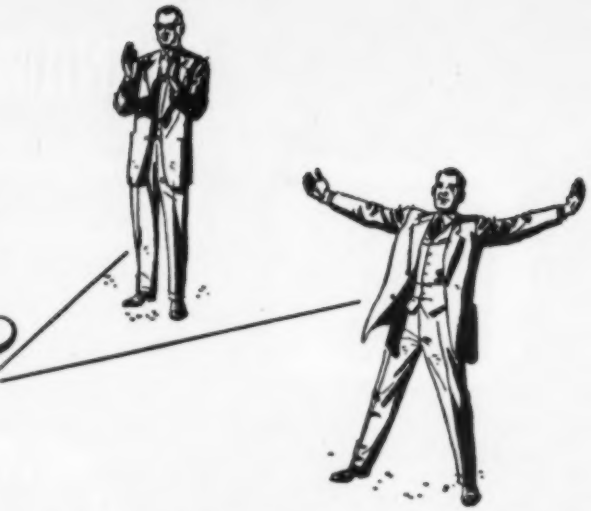
AEROCAT MS Synthetic Fluid Cracking Catalysts

AMERICAN Cyanamid COMPANY

REFINERY CHEMICALS DEPARTMENT, DIV. PR-12
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

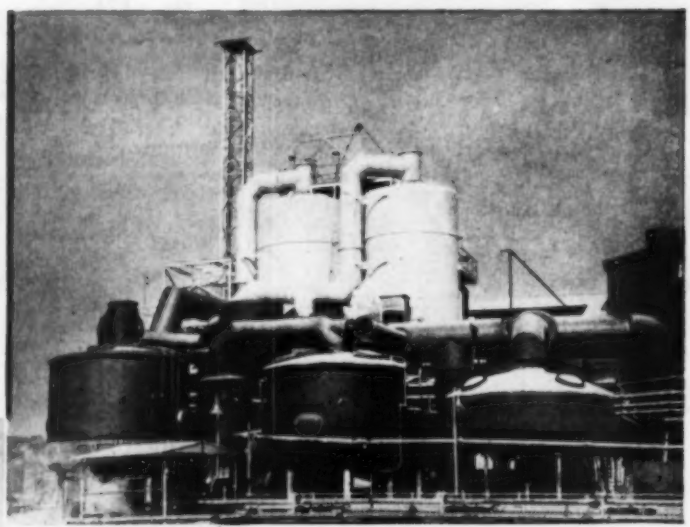
In Canada: North American Cyanamid Limited, Toronto and Montreal

How much sulfuric acid do you need?

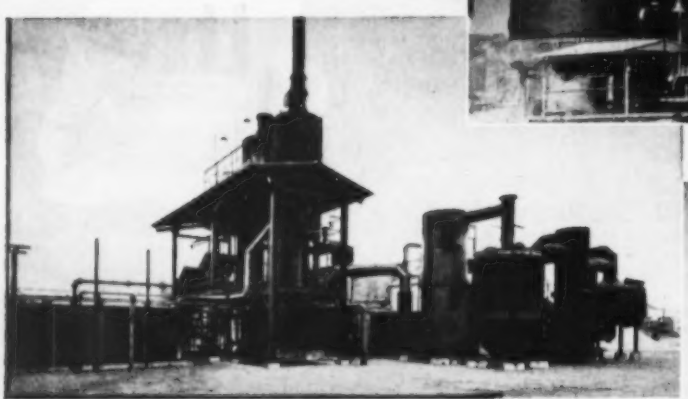


Among the many Chemico-built contact sulfuric acid plants in service today all over the world, one has a capacity of only five tons per day. Another produces more than five hundred tons per day. Others range in between.

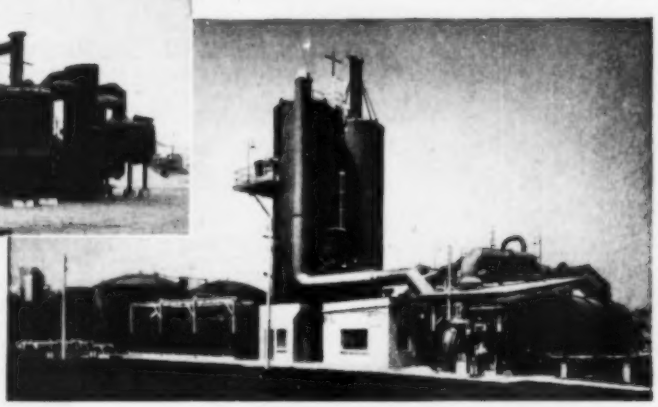
Whatever your sulfuric acid requirements are, Chemico will design and furnish you with a highly efficient plant exactly suited to your needs . . . on a one-contract, guaranteed-performance basis.



500 Tons



50 Tons



200 Tons

CHEMICAL CONSTRUCTION CORPORATION

A UNIT OF AMERICAN CYANAMID COMPANY

488 MADISON AVENUE, NEW YORK 22, N. Y.

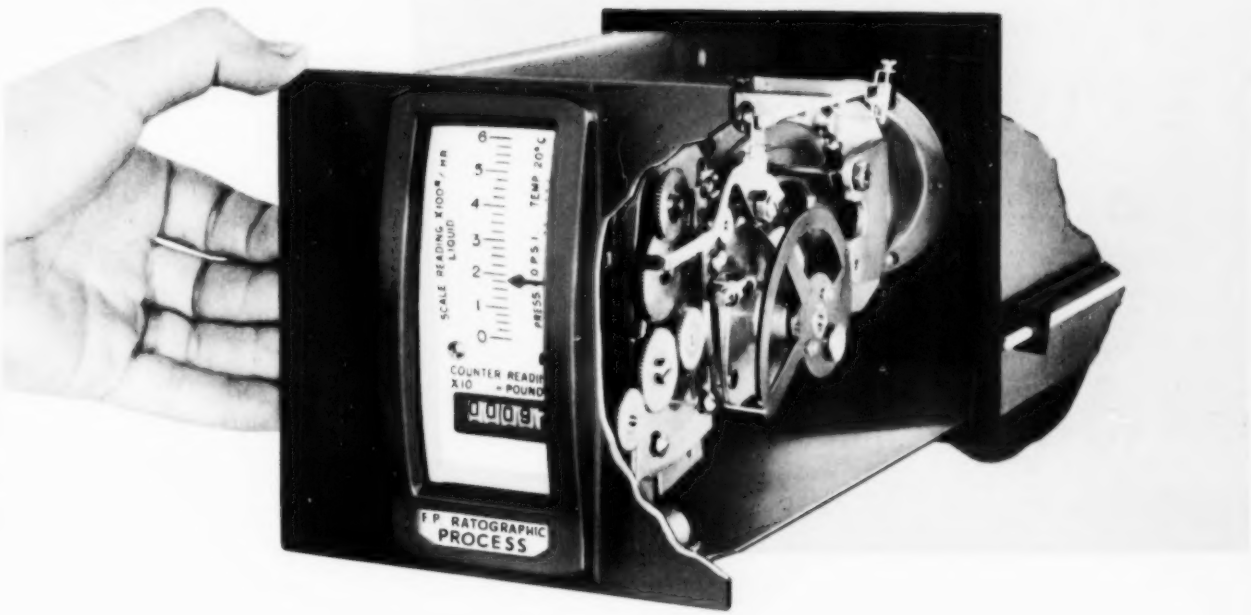
CABLES: CHEMICONST, NEW YORK

TECHNICAL REPRESENTATIVES: CYANAMID PRODUCTS LTD., LONDON • CHEMICAL CONSTRUCTION (INTER-AMERICAN) LTD., TORONTO • SOUTH AFRICAN CYANAMID (PTY) LTD., JOHANNESBURG

Chemico plants are profitable investments

NEW

Ratographic* totalizer



complete with continuous rate indication

- continual integration at rate of 24 times per minute
- dust-proof drive mechanism immersed in oil
- heavy duty 100 rpm — 72 pole synchronous motor
- standard size pneumatic receiver and integrator
- front-of-panel accessibility and removal
- accuracy within 1% of full scale

Here, for the first time, is a *full-size*, rugged totalizer — so designed that it can be used in full size, miniature or graphic panels. A companion to the F & P Ratographic miniature indicator, it is another step in complete process instrumentation developed and perfected by the skilled engineers at Fischer & Porter Company.

The entire unit occupies only six inches square of panel space. In extended position, as shown, instrument continues to function, thus easily enables observation of mechanism. The highly accurate integrating unit gives the equivalent of continuous integration. The many other new features combined in this instrument suggest a careful comparison. Full information on request.

complete process instrumentation

FISCHER & PORTER CO.

*T. M., F&P Co.

2420 County Line Road, Hatboro, Penna.

Company owned sales and service branches strategically located throughout the world.

PSC furnishes 300 styles of BUBBLE CAPS and RISERS

in Any Metal

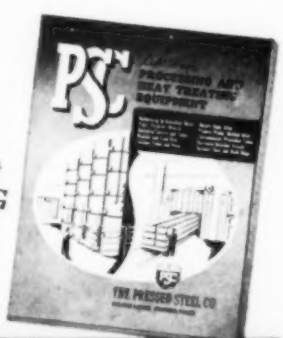
- **ALUMINUM**
- **BRASS**
- **COPPER**
- **NICKEL**
- **STAINLESS STEEL,** any chrome-nickel or straight chrome type
- **STEEL,** carbon

...and Without Die Cost

Being entirely unassociated with any metal producer, PSC regularly fabricates the complete list of ferrous and non-ferrous metals and alloys normally available today. At PSC you can order processing equipment in the one particular metal which best meets your specific heat and corrosion requirements. Service records of fractionating towers, for instance, show that this PSC advantage repeatedly results in better life/cost ratios of bubble caps. Quotations on alternate metals are always available at PSC.

With dies on hand for about 300 standard styles of bubble caps and risers, PSC is in a position not only to save many customers the cost of dies but also to save them design and delivery time. PSC bubble caps are furnished for all methods of tray assembly. Special caps furnished to order. Send blue prints or write as to your needs. You will find, we believe, the largest compilation of engineering data on bubble caps and risers in PSC catalog 52.

Send for Process Equipment CATALOG 52

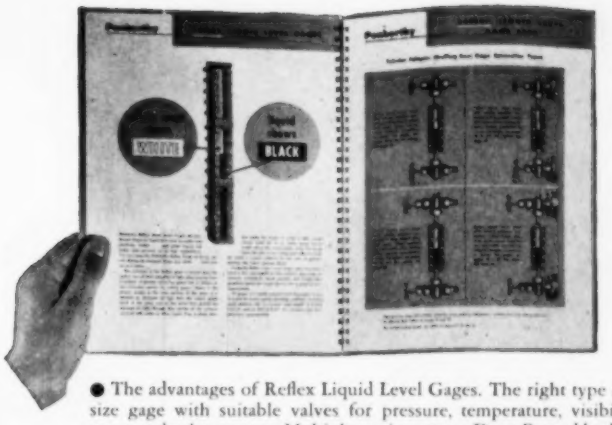


THE PRESSED STEEL COMPANY
of WILKES-BARRE, PENNSYLVANIA

Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

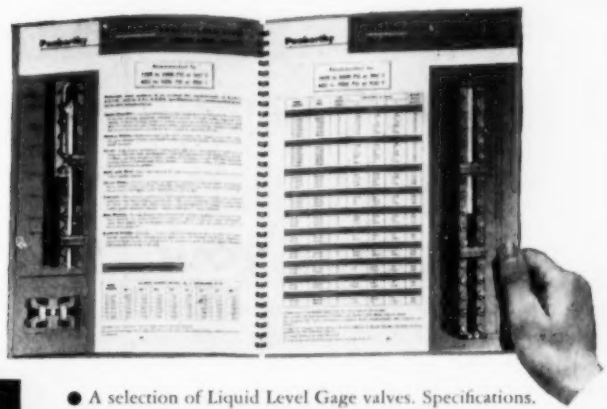
☆ ☆ ☆ OFFICES IN PRINCIPAL CITIES ☆ ☆ ☆

FACTS AT YOUR FINGERTIPS



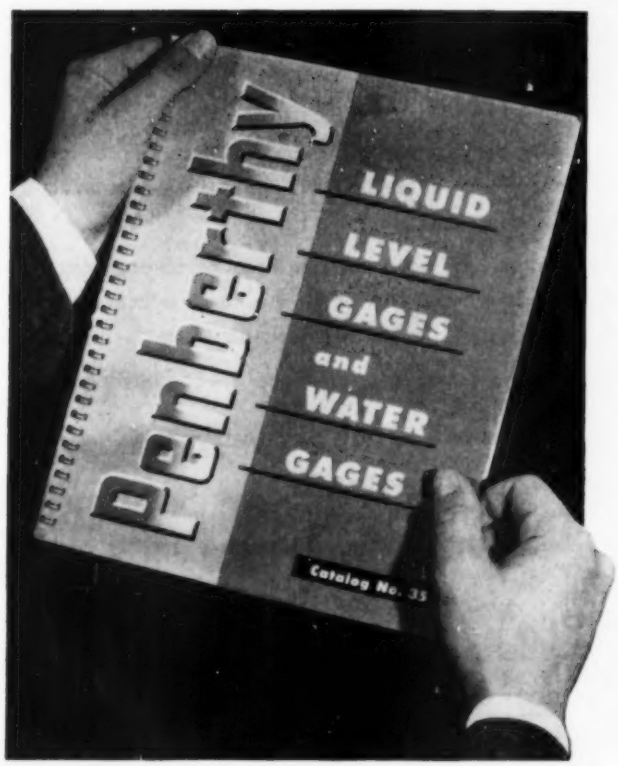
● The advantages of Reflex Liquid Level Gages. The right type and size gage with suitable valves for pressure, temperature, visibility range and valve centers. Multiple section gages. Drop Forged bodies. Pyrex glass. Basic and special designs.

● When to use Transparent Liquid Level Gage Sets. High pressure steam service. Adapters, valves, connections. Types available with recommendations.



● A selection of Liquid Level Gage valves. Specifications. "Floating Shank." Connections and special features.

● Metallurgical specifications. Gage glass and guard rods. Engineering service.



Penberthy's Catalog 35 is jam-packed with illustrated facts and specifications. It is your best guide to selecting the right liquid level gage sets at the most economical cost. In the complete Penberthy line, there are standard products for almost every application. Where your needs are special or unique, use the experience of almost 70 years to solve them. Take a tip from many thousands of satisfied users and write for your copy of Catalog 35.

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...with a Blaw-Knox "Catforming" Plant

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The Atlantic Refining Company "Catforming" process is an economical means for up-grading low grade naphthas to high octane gasoline at 95-100 per cent yield. The catalyst is selective and rugged; the yield-octane relationships are well established by pilot plant evaluation of numerous stocks; and commercial operations have confirmed basic design features.

Chemical Plants Division is licensed to offer Atlantic's "Catforming" process and would be pleased to discuss product yields and qualities, plant investment and operating costs with you. "Catforming" offers an economically attractive solution to your octane problem.

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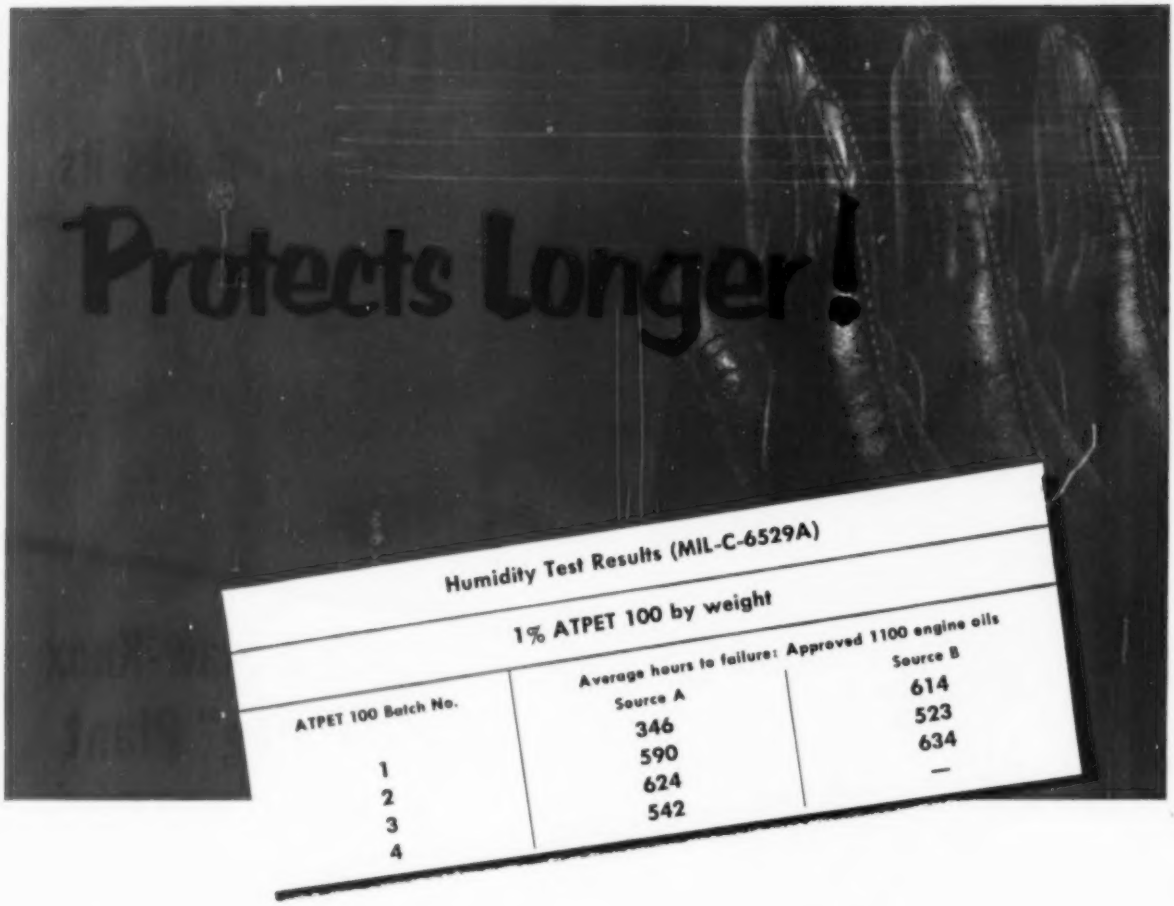

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The Mail Box . . .

. . . and the Best

Dear Editor:

Today I must take the occasion to express my thanks and appreciation for the excellent educational standard and layout of your monthly magazine PETROLEUM REFINER. It has been a great help to me. The practical tendency throughout this magazine helps to explain many strange happenings and difficult problems in our refining industry and stimulates to practical research and development.

The relatively very young and upcoming petroleum industry here in Canada is eager to hear much of the practical experience of the gusher and dry lands in the deep southwest. Your magazine has it and the best.

Warner P. Heinstein
17 Place Du Mordie
P. Quebec, Canada

Better Than Textbook

Dear Editor:

I have suggested a subscription to the REFINER as a text for the graduate course in petroleum refining. It works out better than the standard textbook in the field.

Brymer Williams,
Associate Professor,
University of Michigan,
Ann Arbor.

Liked Symposium

Dear Editor:

We of Blaw-Knox are especially pleased with the fine manner in which you and your associates of the Gulf Publishing Company presented the Economics and Cost Symposium in the October issue of PETROLEUM REFINER.

John F. Gilmore, Jr.,
Blaw-Knox Company, Tulsa.

Press Relations Views

By Claude V. Barrow, Oil Editor, The Daily Oklahoman, Past President, Association of Petroleum Writers

EDITOR'S NOTE: The following is a condensation of a letter written in response to the article, "How Are Your Press Relations?" which appeared in PETROLEUM REFINER *for October.*

The oil industry has made a lot of mistakes in its press relations, but the company public relations men—many of them from old established agencies or businesses—are working out the bugs. The newer group of PR men are learning fast.

However, there are things some of them haven't learned. Here are a few:

Easy on those handouts. Back in the old days of the traveling circus, the press agents figured that 40 percent of the stuff they dished out was printed. The fact that they furnished free tickets and other things helped the situation a lot, of course.

But it is well to note that long before the last war, some of the smart circus men had quit press handouts and that sort of thing. They went to billboards, counter displays and such. They quit trying for newspaper publicity because the results were not worth the effort.

Choose your target. A major company which started its first publicity job other than marketing (which was handled by an ad agency) started flooding

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Modern petroleum product processing finds many applications for Patterson Grease Kettles, due to the range of standard and special types fitting every production demand. Write for full information on these adaptable Kettles telling us of your intended use.
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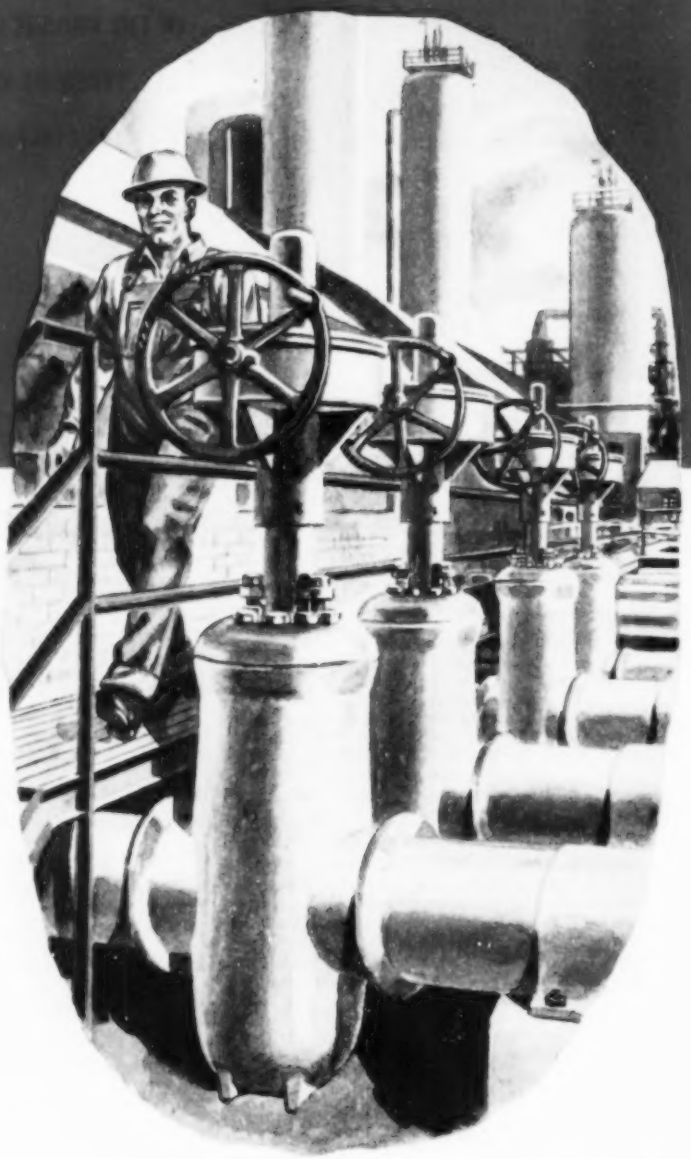
MONTREAL

"FOUR YEARS' FLUE-GAS SERVICE AT 800° F. AND STILL IN EXCELLENT CONDITION..."

W-K-M PROCESS VALVES

(PATENTED)



Four years ago a large southwestern oil refinery installed four 12" W-K-M Process Valves in the flue-gas lines of a hydroformer unit. The flue-gas, containing sulphur, passed through the valves at 800° F. at a pressure of 300 p.s.i. A recent check showed that the valves were still in good shape and the seating surfaces were in good condition.

These valves were standard steel trim except for the seating surfaces which were inlaid with Hastelloy alloy B, which trim is also used for such severe services as hydrochloric acid solutions, sulphuric acid solutions, isopropyl alcohol, hot rich oil and propane and butane.

W-K-M Process Valves have all the features of the Standard W-K-M Valves, such as exclusive leverlock operation, parallel expanding gate assembly, through conduit flow and renewable seats plus other design features especially developed to meet the needs of process service.

Write for W-K-M Bulletin 698 for complete information about W-K-M Process Valves.

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W-K-M Company, P. O. Box 2117, Houston 1, Texas

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Export Office: 30 Rockefeller Plaza, New York, N. Y.

every newspaper and magazine in the country with costly and expensive junk. Well, today that outfit is producing about 80 percent less material and is getting a high percentage of it printed. The trick was a study of the newspaper, magazine, radio and TV fields—all outlets, in fact—and keying particular news to those mediums. For instance, on financial statements. *The Wall Street Journal* and major newspaper financial editors are at the top of the list and get the releases before time of publication.

Too many booklets. I think the companies could reduce the amount of envelope-stuffer type stuff they distribute to the public. If not eliminated entirely, it could be sent to persons who might make some use of it. Apartment dwellers have no interest in how or why to use certain insecticides to protect crops. Many city dwellers receive booklets explaining how to save money by greasing their tractors before running them into the shed at winter's outset.

Press kits wasteful. Some companies spend small fortunes on press kits which, if used, would fill all the news space in a daily edition of a metropolitan newspaper. My kits always go to the Boy Scouts' scrap paper collection via the wastebasket.

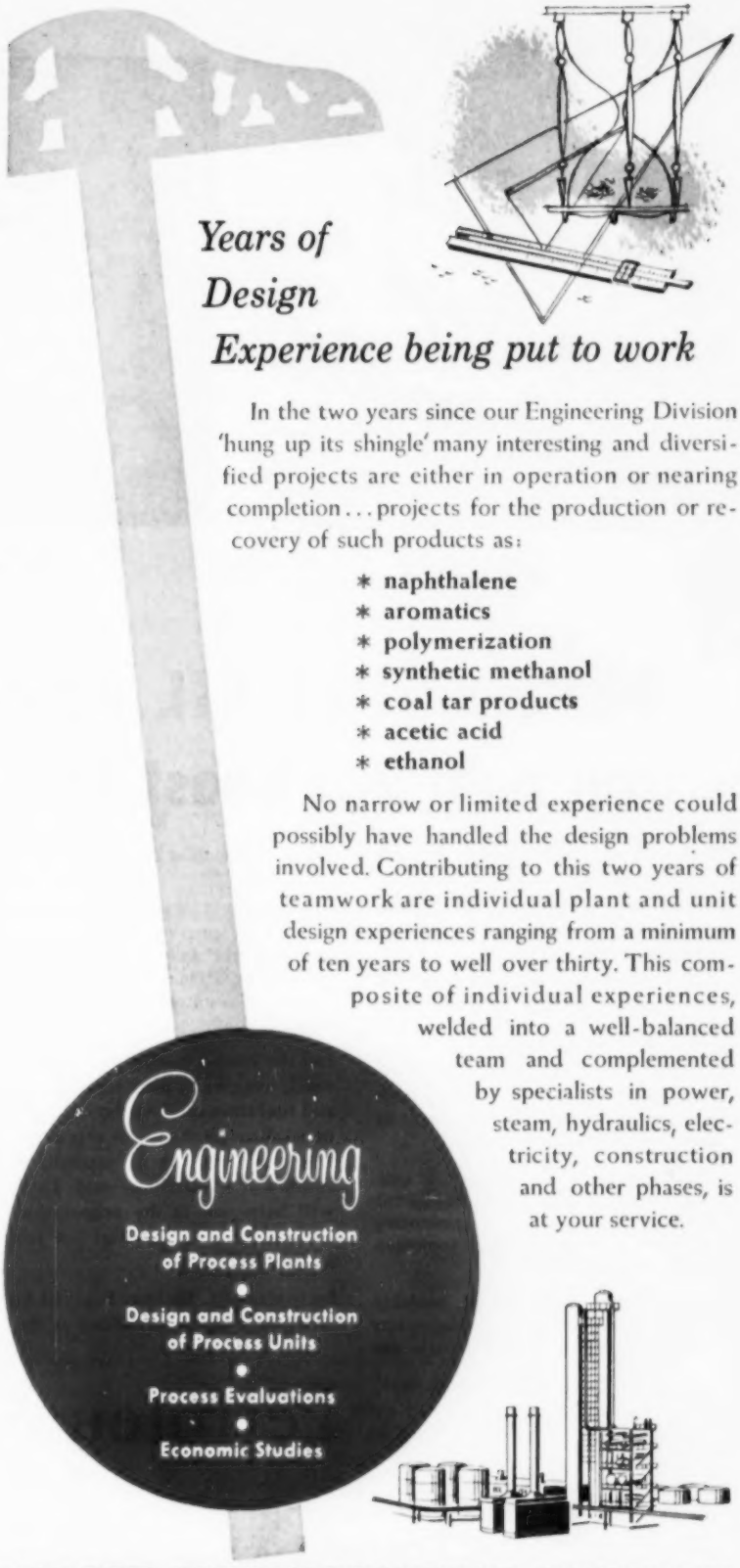
How about the guy in overalls? Did you ever notice that most of the boys send out group photos of the brass, but never a shot of a guy in overalls? These group photos are also marked by the fact that the photographer is a son of a public executioner and lines up the victims so the marksmen can hit the hearts on the first volley. No life, no animation, no smiles. Just blank faces in a line before a brick wall.

Or they'll send you a picture of a mass of plumbing and call it a platformer, a cat cracker, or some other sort of thing, and never realize that possibly several types of equipment are included. They'll never have a workman somewhere in the picture so that the size of the structure can be compared.

Who's got a can opener? I have another little gripe, one with which I get absolutely no place. When the PR boys send out a photo, they encase it between two heavy mailing boards, then wrap the board with scotch tape. They then put it in a heavy mailer, seal all ends, and wrap a piece of heavy binding tape around the thing. I'm working on a tool that will open these encasements without breaking an arm. A standard mailing envelope, purchaseable at any dime store, will protect and carry $1 milion anywhere, any time, and with safety. So why do the PRs let the office boy waste time, paper, material and postage in sending out such stuff?

Magazines are helpful. All those beautiful house organs, brochures, etc., do have a real value. I receive them from at least 24 companies and agencies. I marvel at the color work, the printing, and the vast amount of information printed therein. Some of them go outside the oil industry for special stories. I use them, and am glad to get them.

In conclusion, let me say that if you can drive home the idea to the industry that the press relations phase of their operation is as important to the industry as selling gasoline—and filled with as many pitfalls as general selling—you will have accomplished some good.


Years of
Design
Experience being put to work
In the two years since our Engineering Division 'hung up its shingle' many interesting and diversified projects are either in operation or nearing completion . . . projects for the production or recovery of such products as:
* naphthalene
* aromatics
* polymerization
* synthetic methanol
* coal tar products
* acetic acid
* ethanol
No narrow or limited experience could possibly have handled the design problems involved. Contributing to this two years of teamwork are individual plant and unit design experiences ranging from a minimum of ten years to well over thirty. This composite of individual experiences, welded into a well-balanced team and complemented by specialists in power, steam, hydraulics, electricity, construction and other phases, is at your service.
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Complaints, resulting from clogged oil burner filter screens, can be eliminated in most cases with Du Pont Fuel Oil Additive No. 2

DuPont FUEL OIL ADDITIVE No. 2 can help you boost heating oil sales

With fuel oil in ample supply, you are probably looking for every possible sales feature that will help to improve your market position. And customer satisfaction is a must.

Here's how you can give your customers better service . . . with less servicing.

Du Pont Fuel Oil Additive No. 2 can help you eliminate many complaints arising from plugged filters, screens, and fuel lines. It works three ways:

1. Retards residue formation— The antioxidant properties of Du Pont Fuel Oil Additive No. 2 are effective in reducing the rate of insoluble residue formation in distillate fuel oils.

2. Reduces filter clogging— If insoluble residues *are* formed, this additive acts as a dispersant to reduce particle size and also enables the particles to pass through filters.

3. Inhibits rust formation—In drum storage tests, rust formation above the liquid level was reduced when Fuel Oil Additive No. 2 was added—as compared with untreated fuel oil.

As a result of these three benefits, and the ashless quality of the product itself, clogging of filter screens, nozzles and fuel lines can be practically eliminated through the use of this additive. These benefits can be capitalized in consumer advertising—and Du Pont will help you in the preparation of such advertising material for jobber and dealer use.

For best results, Du Pont Fuel Oil Additive No. 2 should be added at the refinery to freshly prepared stocks. To evaluate its effectiveness in your own stocks, storage tests at 110°F. are recommended as being the most valid. The five strategically located Du Pont Petroleum Chemicals Division laboratories are prepared to conduct such evaluations for you. Samples and full details can be obtained from any of the Du Pont Petroleum Chemicals Division district offices listed below.

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The LOOK BOX for December . . .

Your Annual Index

THE ANNUAL index for the PETROLEUM REFINER is included in this issue as an insert. This resume includes a subject index which covers each technical article that appeared in the magazine in 1953. You will find the subject index thoroughly cross-referenced as well as a complete author index. The index is inserted between pages 192 and 193.

Runs Still Important

IF THE INDUSTRY continues to temper its operations, chances are good that its economic position will show substantial improvement by the end of the year. The most important question is refinery runs. Oversupply that has plagued the industry for several months despite record consumption rates can be improved if refinery activity is held to the relatively low levels of recent weeks.

Excessive motor fuel stocks are the most troublesome market factor today. Holding refinery operations to around 6.9 million barrels daily or less would prevent the output of too much gasoline, and that would be extremely desirable. Additional progress along this line could be achieved if yields were adjusted to produce larger quantities of heating oil and less gasoline. Such a course would help bring motor fuel inventories nearer desired volumes.

Gasoline stocks have shown relatively little change since the end of June, although they normally would have been reduced substantially during the heavy consuming season. High refinery runs and resulting gasoline output offset record consuming rates. Stocks in mid-November totaled 145 million barrels, 21⅔ million barrels more than a year ago, and compared with 146 million at the end of June. By the end of March, those stocks will grow considerably.

Although distillate stocks are considerably higher than they were a year ago, a lengthy cold spell would go far in reducing those stocks. On the other hand, if winter proves mild, too much distillate would be in tanks by the arrival of sping.

Colossus in Government

HOW BIG is our government today?

So big, the Chamber of Commerce of the United States tells us, that if one added all divisions of state, local and federal governments, you could find a top executive job for every citizen in a city the size of Phoenix, Ariz., (population 331,770).

Actual count reveals there are 116,743 major units of government in the U. S. today. This includes the federal government, the governments of the 48, states, 3049 counties, 16,778 municipalities, 17,202 townships, 67,346 school districts and 12,319 special districts.

Broken down into all the principal subdivisions of government, the total would be many times 116,743. For instance, within the federal government alone there are 13 departments, 9 agencies, 19 commissions, 29 administrations, 22 corporations, 630 offices, 127 services, 107 bureaus, 627 divisions, 32 branches, 58 boards and 444 miscellaneous units such as missions, colleges, commands, projects, etc., making a total of 2117 distinct segments of federal government.

Breaking down state and local governments into subdivisions would add still more to the 116,743 total.

Oh yes, and each one of them costs. In the year ending last June the total cost of federal, state and local governments was $101.5 billion or $646 for every man, woman and child in the U. S.

Postals and Products

ONE OF THE services that PETROLEUM REFINER offers its readers at no cost or obligation to them is the free information via prepaid postal card, inserted at the beginning of the What's New department. The purpose of this service is to allow the reader—that's you—to get more information on the equipment items described either in the What's New department or in the advertisements. Most often it is impossible to describe a new item of equipment to your satisfaction in the limited space available in the magazine. Therefore the postal cards, which will bring you technical bulletins or catalogues from the manufacturer. Once again, you are under no obligation when you "Circle No. . . . ." They are there to help you.

Easier to repack than ever before

LIGHTNIN SERIES SE (gear drive). Sizes 1 to 25 HP. Also available in V-belt drive.

No wrenches needed to shut off stuffing box from tank contents

TO SHUT OFF WITH TANK FULL, operator loosens a set screw and turns handles on bronze housing. It's as easy as closing a valve.

INSIDE THE TANK, a Teflon gasket is compressed between the seal collar and end cap. This positively seals off tank contents.

TOP ENTERING turbine and paddle type mixers for open or closed tanks. Sizes 1 to 500 HP.

LIGHTNIN PORTABLE MIXERS ... Used everywhere for hundreds of fluid mixing jobs. Thirty models to choose from. Sizes ⅛ to 3 HP.

These two new LIGHTNIN Side Entering Mixers cut maintenance time in half, they're so easy to service.

When stuffing box needs to be repacked, your maintenance man just loosens one set screw. Then he easily shuts off the stuffing box from tank contents, by rotating the outboard bearing holder, which has two easy-to-get-at handles.

Returning the mixer to operating position is just as easy and foolproof. You've never seen anything so simple and slick in a side entering mixer.

This is just one of the features that will sell you on these new LIGHTNIN Mixers. Others are:

Your choice of stuffing boxes or mechanical seals to fit the mixing job.

Smoother operation because new vertical motor mounting (on gear drive units) moves center of gravity closer to tank, minimizing vibration.

Full guarantee says the mixer will do the job and do it *right*, or your money back.

Specify the new LIGHTNIN Mixers for gasoline blending, lube oil blending, sediment control—and wherever there's a *big* mixing job that must be done right. Call your MIXCO representative today, or write us for details.

"Lightnin® Mixers"

GET THESE HELPFUL LIGHTNIN CATALOGS

This library of mixing information is yours for the asking. Catalogs contain helpful data on impeller selection; sizing; best type of vessel; valuable installation and operating hints; complete description of LIGHTNIN Mixers.

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- ☐ B-75 Portable Mixers (electric and air driven)
- ☐ B-102 Top Entering Mixers (turbine and paddle types)
- ☐ B-103 Top Entering Mixers (propeller type)
- ☐ B-104 Side Entering Mixers
- ☐ B-106 Condensed Catalog (complete line)
- ☐ B-107 Mixing Data Sheet

Please send me the catalogs checked at left.

Name_____ Title_____

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Future Executives

IF WE ARE TO maintain the rapid pace of industrial development set in the first 50 years or so of this century, we must continue to have the same high quality of leadership that we have had in the past.

How fast this development has been was brought to mind in a statement by Crawford H. Greenewalt of E. I. duPont de Nemours and Company in a speech before the Executives' Club of Chicago. He said, "It has been estimated that half our present national working force is engaged in production and sales of things unheard of generally in 1902. A very large number are concerned with developments new since 1928. Should this trend continue, half our working population in the year 1978 may be making and selling things as yet unknown."

Such progress can only occur, he continued, if more and more bright young men are encouraged to enter the industry. The chances of developing the executives needed will be greatly enhanced as the number of such employes increases.

Looks Ahead On Fuel

WITHIN SEVEN years the U. S. will be unable to meet its needs for petroleum imports because of strong foreign demand for oil in world markets, according to one man's predictions. Consequently, the U. S. will eventually limit residual fuel oil use to that of bunkering ships and will draw heavily on coal supplies for fuel and power, obtaining some liquid fuels as well as much more electric power from coal. While he foresees an "almost explosive expansion" in U. S. consumption of coal, he thinks that only a "minor part" of liquid fuel needs will come from shale.

These forecasts were made by Eugene Ayres, Gulf Research & Development Company, in a letter made public by the National Coal Association. He saw signs that U. S. coal consumption would rise to 600 million tons in 1958, 640 million in 1960, 900 million in 1965, and 1,200 million in 1970.

Reasons for coal expansion were cited by Ayres as follows:

- Increasing demands for electric power.
- Inadequate potential hydro-power capacity.
- Expected peaks of U. S. production of natural petroleum and natural gas around 1965.
- Expected peak of world production of petroleum between 1985 and 2000.
- Anticipated high rates of demand for liquid fuels.

By 1960 the U. S. will be unable to import all the oil needed because of the competitive needs of the rest of the world, Ayres predicted. By 1970 the U. S. will want to import 4.5 billion barrels, while the world shortage will be nearly 4 billion. And by 1980, he went on, the U. S.—and the world—will have around 7 billion barrels per year less than needed.

Because of these conditions of shortage, stated Ayres, the price of petroleum will be high enough to justify the conversion of coal to liquid fuel. No residual fuel oil will then be sold except that required for ship bunkers. However, he thought that only a minor part of liquid fuel needs would come from shale.

Ayres said his estimates assumed that demand for liquid fuels would not be slowed down by higher prices and that the problems involved in increasing the mining of coal could be solved quickly enough to keep pace with demands.

Banner Year In 1953

IN OUR LOOK BOX for December, 1952, we told our readers of the PETROLEUM REFINER policy directed toward publishing the technical achievements of the greatest names in the industry. No phase of refining, natural gasoline and petrochemical operations is neglected for want of adequate, experienced, authoritative, editorial coverage at whatever cost and effort it takes to do the job. We are proud that we continued to bring you these specialists in 1953.

In addition to the regular articles for 1953 we brought to your desk special issues and symposia covering economics and cost data, natural gasoline, fuel oil reduction, new processes, petrochemicals handbook, maintenance series, management series, desulfurization problems and other special features. We'll continue to keep them rolling to you in '54.

We always like to hear from our readers and to check into their suggestions.

Is U. S. Oil Industry Being

Yes— Increasing dependence on foreign oil threatens entire domestic industry, says IPAA President

C. H. Lyons, President,
Independent Petroleum Association of America,
Shreveport, La.

THE U. S. is confronted with critical decisions on foreign economic policy. In the whole complex field of foreign trade, one of the most urgent and controversial issues will be the formation of a sound national policy on petroleum imports.

Great emphasis is being placed on relaxation of our "trade barriers." Unfortunately, most speakers and writers supporting outright free trade make no exceptions. Too many fail to distinguish between trade in Christmas tree ornaments, and trade in strategic materials—such as oil.

In the final analysis, outright free trade in many critical materials would disarm us economically. Economic disarmament—the weakening of basic industries essential to our defense—would be as disastrous as military disarmament. Free trade with no limitations would have this effect.

The vital task of petroleum discovery and development, because it is essentially a risk business, is one of the first to show ill effects from unrealistic levels of imports. Within the past five years, the domestic industry has experienced repeated serious cutbacks in its production during periods in which there were no corresponding curtailments, and in fact were increases, in imports. This happened in 1949, 1950, early in 1953, and to a serious extent during the latter part of 1953.

I do not mean to imply that all these hardships were caused by imports, but there is no denying the fact that imports were an important factor, and were not reduced as demanded by both equity and accepted industry policy.

Unique Advantage. Unlike any other major American industry, domestic production of oil is regulated in light of conservation experience. It is controlled by the various states under their respective conservation laws. Foreign oil, on the other hand, is in no way bound by domestic conservation practices. Because of this, oil imports, in contrast to other imports, enjoy a unique competitive advantage in the domestic market.

It is because of this competitive advantage that some method must be devised, in the national interest, to assure both imported and domestic oil equitable access to the U. S. market. The domestic industry has asked only for a situation under which imported oil would share any decrease, or increase, in the domestic market, on an assured basis.

As stated in the official position of the Independent Petroleum Association of America, adopted at its 1953 annual meeting in Fort Worth, U. S. producers are concerned only with the effectiveness, not the means, of assuring a proper place for imports.

Strangely, if all statements of policy from various industry sources are accepted, no "controversy" exists on the question of oil imports. The domestic oil producing industry, through IPAA, has long recognized a place for imports. All segments of the industry, both importer and domestic producer, have subscribed—presumably in good faith—to the policy that imports should "supplement" and not supplant domestic production, and that "fair and equitable relationships" should obtain between imports and total U. S. demand.

TABLE 1

Ratio of Total Imports to U. S. Demand

AVERAGE	Percent
Prewar Years:	
1935-41	5.5
War Years:	
1942-45	4.8
Postwar Years:	
1946-51	10.3
1952	13.1
1953 (Estimated)	13.8

Source: U.S. Bureau of Mines, except 1953 imports, which are partly based on importing companies' estimates to Texas Railroad Commission.

Disagreement arises, therefore, over the degree—and not the principle—of imports. An examination of the extent that foreign oil has encroached on the domestic market shows, beyond doubt, that imports are "supplanting" U. S. production.

For example, in 1938 the U. S. was a net petroleum exporter by 383,000 barrels daily. Today, we are a net importer of approximately 700,000 barrels a day. In these 15 years, the domestic industry has lost a market for more than 1 million barrels of oil a day.

Furthermore, in the last five years, total imports of crude petroleum and products have increased more than 100 percent. For this same period, U. S. production is up only 20 percent and total domestic demand only 34 percent. Table 1 further illustrates the extent to which foreign oil has been taking an ever increasing share of the domestic market.

Recent trends, in the fall months of 1953, provide an even more convincing picture. Oil imports remained relatively unchanged, at around 1 million barrels daily. Drastic oversupply conditions forced production cutbacks in major producing states. Total reductions in allowables in six states reached approximately 600,000 barrels daily in less than three months, resulting in a lesser but substantial reduction in actual production. These figures speak for themselves.

Unless some assurance is forthcom-

* See SAYS "YES," Page 211

Drowned By Excessive Imports?

No— We must retain our interest in foreign oil as insurance against future domestic shortage, declares economist

A. J. McIntosh, Economist,
Socony-Vacuum Oil Company, Inc., New York

THE QUESTION of supplementing our domestic crude oil supply with imports is of major importance and has been misinterpreted by many.

True, the U. S. is not running out of oil. We are, however, using up our proved reserves 3½ times as fast as the rest of the free world, and the ratio of our known reserves to our consumption is less than what it was just before World War II. Common sense dictates that we supplement our domestic supplies with oil imports to retard the depletion of our oil resources. Here are some of the reasons:

- Oil is an exhaustible resource which is not being replaced as it is consumed.
- The U. S. consumes about 60 percent of the oil used in the free world, but has only 25 percent of the free world's proved reserves. America's oil prospects have been tested by 1½ million wells, compared with about 2000 drilled in the Middle East, where known reserves already are nearly twice as large as ours.
- Without imports we would have had substantial crude shortages in 1945, 1946, 1947, 1948 and 1951. (During the severe winter of 1947-48 U. S. consumers clamored for oil imports.)
- On the West Coast, production of the types of crude needed is at maximum rates, yet falls short of meeting demand, and imports have been necessary from both the civilian and military standpoints, as was witnessed during the Korean War.
- The President's Materials Policy (Paley) Commission, reporting in June, 1952, forecast U. S. oil consumption of 13,700,000 barrels daily in 1975, or almost twice the 1952 rate. Assuming domestic production of 11,200,000 barrels a day in 1975, the report points out we will still require oil imports of 2½ million barrels a day and that only 1,300,000 barrels of that amount will be available from Western Hemisphere sources.

Tomorrow's Insurance. The economy of this country is geared to oil. We must retain and protect our interest in foreign oil reserves as insurance against a future shortage of our own supplies during either war or peace. We cannot expect other countries to cooperate in making their oil resources available to us when we need them unless we offer fair and reasonable treatment to the oil exports from these countries at all times.

Unless additional oil imports are available to us in the years to come, we will find it difficult, if not impossible, to meet expected demand for oil and maintain the present ratio of proved reserves to production in the U. S. To maintain the present ratio of proved reserves to production in the U. S. over the next 20 years without additional imports, the oil industry would have to find a billion barrels more oil a year than has been discovered annually in this country since World War II. And please bear in mind that since 1946 we have had a greater program of exploration and development drilling than ever before.

Yet despite this long-range prospect in the domestic supply-demand relationship we have at the moment substantial excess crude producibility and large stocks of products in storage. It is not going to be easy to maintain a sound long-range program, with the cyclical ups and downs which will always be with us. It will require a high order of intelligence and statesmanship to maintain access to foreign oil and at the same time have a healthy domestic industry, yet both must be preserved.

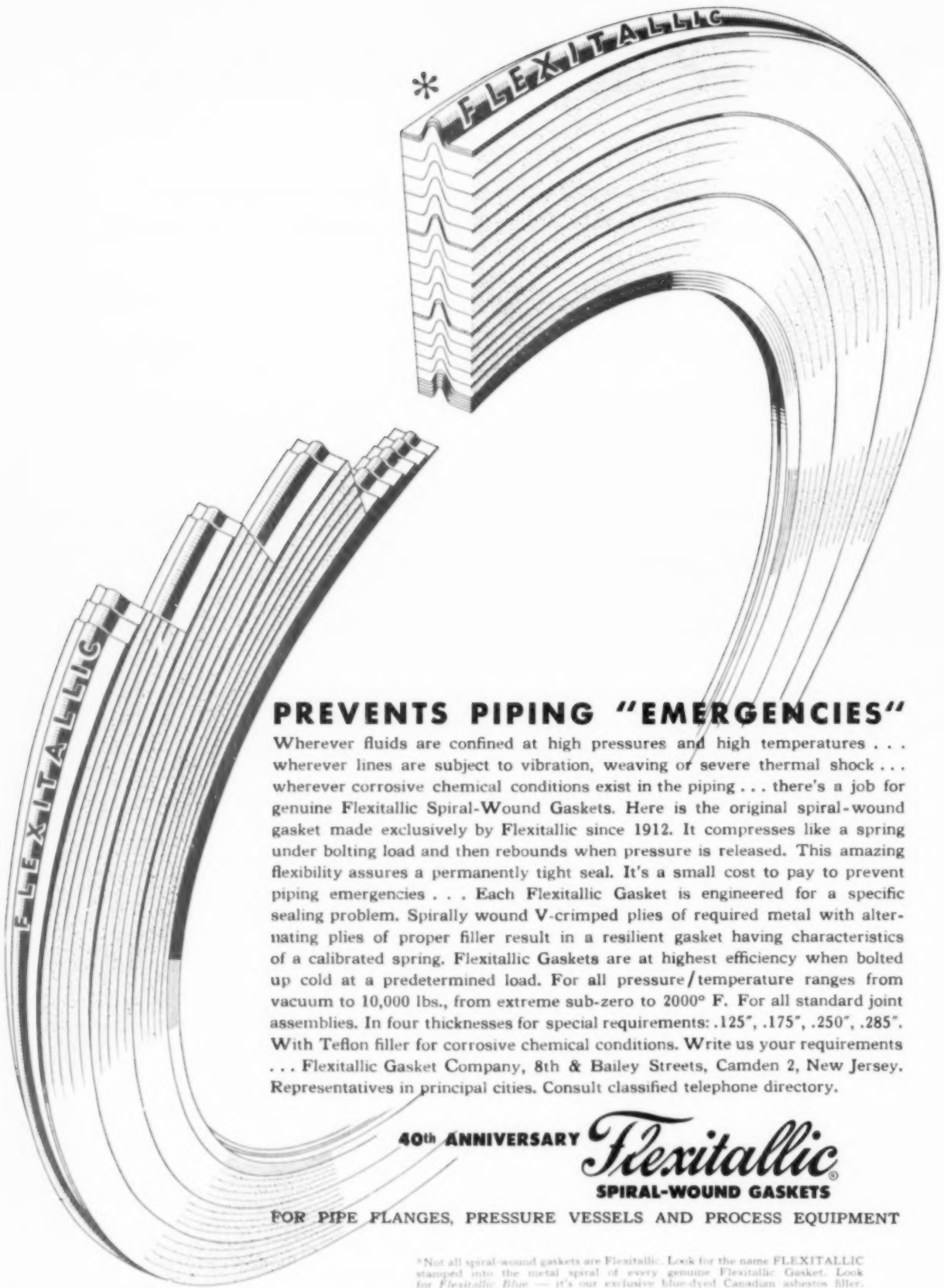
There is every present indication that over the long pull we must look forward to obtaining a gradually rising percentage of our own requirements from beyond our borders. To forfeit our right to that foreign oil in an effort to solve a temporary oversupply at home would be to jettison fuel at the start of a trans-ocean flight against head winds of unknown strength. Petroleum imports cannot be placed on a "feast and famine" basis any more than can domestic production.

To the argument that we must be prepared to depend on oil within our own borders in time of war, the obvious answer is that in neither of the last two great wars did we fight alone or could we have. Just as nations succeeded city states and principalities succeeded tribes, so the world now seems to be coalescing into supranational units in which we must join or perish. It would be suicidal not to develop in peacetime the economic cooperation we have found twice indispensable in war. That this foreign oil is available now to the U. S. and other friendly nations and not to our enemies is a credit to the competitive and aggressive discovery efforts of American companies.

Some of that development was undertaken with the direct encouragement of the U. S. government. The resulting contracts, concessions and trade agreements gave our nationals access to a large portion of the available oil production of the world outside the U. S. That access is conditioned on the continued production and sale of oil.

The charge has been made that oil imports are flooding the country to the detriment of domestic producers. Let's take a look at the figures. First, we should distinguish between the two

• See SAYS "NO," Page 212



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Who's Building . . .

World's Largest Orthoflow Being Built at Philadelphia

Atlantic Refining's 45,000-barrel-a-day fluid cat cracker is mushrooming.

The world's largest Orthoflow fluid catalytic cracker is rapidly taking shape at the Philadelphia refinery of The Atlantic Refining Company. The unit, shown above at an early construction stage, is being constructed by The M. W. Kellogg Company, subsidiary of Pullman Incorporated.

The new cat cracker will have a total reactor thruput of 45,000 barrels a day. It is one of 11 Orthoflows, either completed or under construction, which have been designed by Kellogg since the company first introduced the new model in 1951.

A new alkylation plant is also under construction at Atlantic's Philadelphia refinery. This large unit incorporates the Kellogg cascade reactor, a design that provides high quality alkylate at lower investment and operating costs.

Commercial Solvents Hikes Production of Ammonia

More than 70,000 tons of nitrogen-bearing ammonia and 15 million additional gallons of methanol will be produced at Commercial Solvents Corporation's recently completed Sterlington, La., facilities. Costing more than $20 million, the new facilities will double the corporation's production of both basic chemicals.

Commercial Solvents' new ammonia plant is the first of the chemical industry's privately financed postwar nitrogen expansion programs to be completed and in production. The ammonia produced will be processed into approximately 75,000 tons of ammonia nitrate fertilizer and 30,000 tons of nitrogen solutions, both for use in crop fertilization.

Approximately 50 Mmcf of natural gas, principal raw material used in making these chemicals, will be required each year. It will be drawn from Louisiana and Texas sources.

Ohio Standard Starts Work on Lima Cat Reformer

Construction has started on a 12,000-barrel-a-day catalytic reformer at the Lima, Ohio, refinery of The Standard Oil Company (Ohio). The $7.5 million unit is being erected by Procon.

American Cyanamid Gets Louisiana Tax Exemption

Exemption from ad valorem taxes for ten years has been granted by Louisiana's board of commerce and industry to American Cyanamid Company for a natural gas-based nitrogen chemical plant

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Who's Building . . .

in JeffersonParish, La. The plant is to cost an estimated $67 million.

Construction, already under way, is scheduled for completion by December 31, 1954. Units of the plant include an ammonia plant, two hydro-cyanic acid plants, a sulfuric acid plant, an ammonium sulfate plant, two acrylonitrile plants and two oxygen plants.

South Korea Said to Be Pressing for Refinery

South Korea reportedly is pressing for construction of a refinery sufficient to handle its domestic petroleum needs as part of a rehabilitation program. It is understood that the country is making its plea through the United Nations Rehabilitation Agency.

U. S. government officials concerned with petroleum activity abroad are apparently opposed to the idea. They say it would almost have to be shown that refinery capacity in the general area is insufficient for the U. S. to go along with the request. They point out that there is plenty of capacity in Japan and Formosa. The Formosa refinery, they add, is operating at only half capacity now. It is also thought unlikely by these and other sources that private oil companies operating in the Far East would favor a South Korean refinery.

Frontier Nears Completion Of Tonawanda Expansion

An extensive modernization and expansion program is nearing completion at Frontier Oil Refining Company's Tonawanda, N. Y., refinery. Frontier is a subsidiary of Ashland Oil & Refining Company.

A new Fluid catalytic cracking unit and auxiliary equipment which went into operation recently increased the refinery's capacity to 30,000 barrels a day. The Fluid unit itself has a fresh-feed charge capacity of about 12,000 barrels a day.

Expansion of the refinery's tank facilities began two years ago, and, when completed, these facilities will total about 1,300,000 barrels, compared with 480,000 barrels when the expansion started. Also involved in the construction program are an enlargement of the present laboratory, new facilities for loading lake tankers and barges, and a new loading rack.

Cities Service Reports Progress at East Chicago

Construction at the East Chicago, Ind., refinery of Cities Service Oil Company (Del.) is proceeding on schedule, according to a recent issue of *Empire*, a Cities Service publication. A 30,000-barrel-a-day topping unit and a 12,780-barrel-a-day Fluid hydroformer now under construction at East Chicago are expected to be completed next year.

Brick work on buildings for the $2 million crude topping unit is complete and the atmospheric tower was sched-

Continued on Page 142

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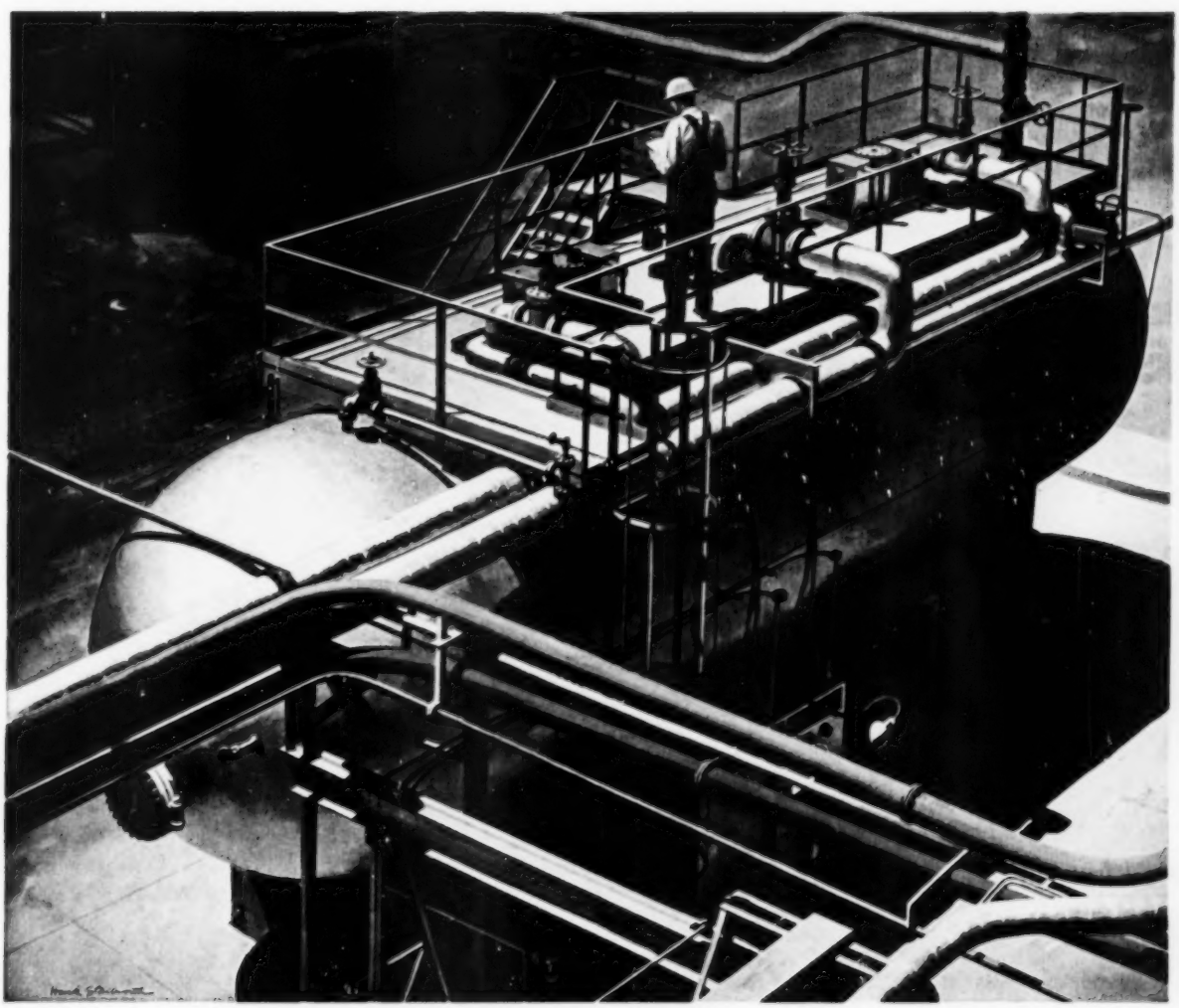

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2. — Metalations (organo-sodium compounds),
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4. — Replacement of an active hydrogen
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Foreword

Desulfurization Symposium

RUNNING in the octane race, refiners are taking a close look at every scheme which will make the fuel needed for high-compression ratio engines. The desulfurization processes, one of the methods getting close scrutiny, increase the lead susceptibility and in turn the octane number of gasoline.

For a number of years research has pointed at sulfur in gasoline as the biggest detriment to tetraethyl lead efficiency. Recently more extensive studies have been made and an even more dramatic picture is presented. One such study showed that the TEL efficiency of typical gasolines containing 0.09 percent sulfur was cut down to 46 percent as compared with a sulfur-free fuel. Further investigations have shown just what changes both TEL and sulfur compounds undergo in engine precombustion actions.

Though the complete removal of sulfur compounds is both difficult and uneconomical, desulfurization processes are available which will remove up to 99 percent of the sulfur content. These processes may be roughly divided into the vapor phase catalytic processes and the liquid phase extraction processes. Conversion processes, which change the mercaptan sulfur to disulfides, offer no improvement in lead susceptibility since the sulfur is not actually removed. Catalytic reforming processes for improving octane are also excellent desulfurization processes.

The gasoline fraction, however, is not the only stream needing sulfur removal. The demand for low-sulfur distillates has been aggravated by the increase of sulfur in crudes presently reaching refineries. Sulfur in kerosine adversely affects its color and char value. Sulfur in diesel fuel has a deleterious effect on engine cleanliness and wear. Extraction processes are available for removing sulfur from these distillates and recently a hydrogen desulfurization for this purpose has been developed.

Desulfurization is also counted as a major virtue in processes developed for the preparation of catalytic cracking feed stocks. No doubt new processes developed for this purpose will keep pace with the growth in catalytic cracking.

In this symposium you will find a complete picture of the sulfur problem in processing and details on the various processes available for desulfurization.

John J. McKetta

Editorial Director

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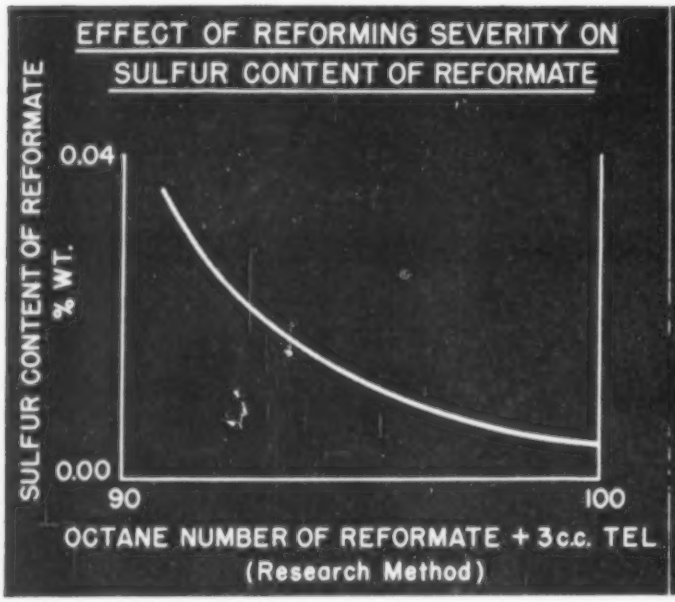


Figure 1. Reforming severity affects sulfur content of reformate like this.

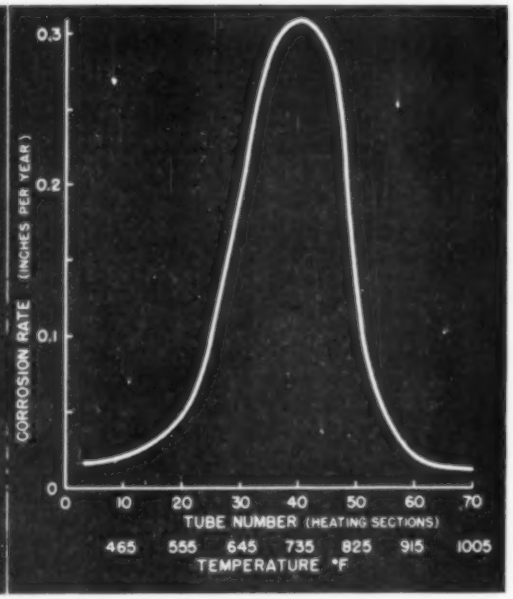


Figure 2. Corrosion rates of tubes in Polyform service.

Symposium on . . .

Desulfurization Today

How desulfurization fits into the refining picture is outlined in this introduction to nine popular desulfurization processes.

V. A. Kalichevsky and E. H. Peters, Magnolia Petroleum Company, Beaumont, Texas

REMOVAL OF SULFUR from petroleum begins with the first application of heat and occurs during essentially all processing operations. However, the quantity of sulfur removed by the conventional refining processes is incomplete and the use of special desulfurizing procedures can seldom be avoided.

Not all desulfurizing processes are alike. In some instances charge stocks and in others products are desulfurized. Some processes may remove sulfur compounds by extraction with solvents or chemicals. Others may break them down by application of heat in the presence of catalysts. Selection of the process is a local refinery problem which depends on the product to be desulfurized and the degree of desulfurization required.

Sulfur compounds in petroleum are not alike. The sulfur compounds remaining in cracked stocks are generally of the more stable type. Those in gases and light distillates from cracking are formed from decomposition of the less stable sulfur compounds and appear frequently as hydrogen sulfide and mercaptans. A few of the sulfur compounds are unstable and break down at temperatures no higher than those required for crude topping. Other sulfur compounds are refractory and are not decomposed to hydrogen sulfide even at conditions requiring for coking. Usually in crude oil the sulfur concentrates in the heavier fractions which contain the bulk of the sulfur.

In thermal and catalytic cracking, sulfur removal increases with the temperature. Also, catalytic cracking removes more sulfur from the gasoline fractions than thermal cracking.

Some desulfurization processes are similar to the cracking processes with the exception that catalysts and treating conditions are selected to promote decomposition of the sulfur compounds in preference to the hydrocarbons. However, if drastic desulfurization is required, cracking of some of the hydrocarbon molecules cannot be avoided. The product loss on catalytic desulfurization can be decreased by the introduction of hydrogen. The processes employing hydrogen increase the paraffinicity of the product.

Removal by Use of Solvents—Removal of sulfur compounds from oil may be accomplished also by the use of

various solvents such as sulfur dioxide, amines, caustic, sulfuric and hydrofluoric acids. The best method for the removal of sulfur is determined by the stock to be desulfurized and the desired properties of the products. Also air and stream pollution may have a bearing on the selection of the process.

Refining of petroleum distillates with caustic solutions is rapidly acquiring a considerable importance in plant operations. This may be attributed to the change in the nature of the sulfur compounds found in today's gasoline distillates as compared with the petroleum distillates manufactured in the past. Mercaptans may represent an appreciable proportion of the sulfur compounds present. Their removal can effect a considerable reduction in the total sulfur content of the light petroleum fractions.

In the past mercaptans were frequently converted to disulfides but this practice is less universal now. This may be ascribed to a better understanding of the effects of these two classes of sulfur compounds on the properties of gasoline. Conversion of mercaptans to disulfides is done primarily for improving the odor of the product and not their performance in service. This introduces new chemical compounds in the oil which may be more deleterious to product quality than the original mercaptans. The tetraethyl lead response and the oxidation stability of the gasolines containing the disulfides might be the same or even poorer than that of the original mercaptans. Although mercaptans and disulfides as a class may be about equally detrimental to TEL susceptibility[3] as shown in Table 1, differences in the TEL susceptibilities of mercaptans found in the gasoline distillates may vary within wide limits as shown by the data presented in Table 2. Data in the last table also indicate the magnitude of the TEL savings which might be effected by extracting mercaptans from some of the typical gasoline distillates instead of converting mercaptans to disulfides.

Mercaptans and disulfides are not the only sulfur compounds that affect the TEL susceptibility of a gasoline. However, the relation between the total sulfur content and the TEL susceptibility is even more indefinite than that of mercaptans or disulfides and varies with the individual refinery stocks.

Distribution of Sulfur in Products—Sulfur distribution in products from a typical refinery and a typical catalytic cracking unit are shown in Tables 3 and 4, respectively. This varies with the local conditions and the data are presented for illustrative purposes only. In processing a crude oil, corrosion of equipment is caused at least partially by the presence of sulfur. This is illustrated by the data presented in Figure 1 which refer to reforming operations.[1] It may be noted that corrosion is greatest somewhere in the middle of the tubes in a polyform furnace, indicating that after the most reactive compounds are transformed into less corrosive products the rate of corrosion decreases. In order to reduce corrosion losses, desulfurizing processes may be applied to charge stocks, thus reducing the loss of metal. Corrosion is higher at higher reaction temperatures and the benefit of employing desulfurizing processes to charge stocks increases with the operating severity.

In view of the general rise in the sulfur content of crude oils processed, the importance of desulfurization increases even though it may not be the same for all the refineries.[2]

Reforming Excellent for Desulfurizing—The catalytic reforming processes employed for improving the octane rating of gasolines are excellent desulfurizing processes. This is shown by the data presented in Figure 1. The amount of sulfur removed is frequently 90-99 weight per cent of the quantity present in the charge stock.

No universal remedy has yet been discovered for solving all the world's problems and the same applies to the petroleum desulfurization methods. This also explains the variety of desulfurizing processes available on the market and their selection for the individual refineries requires a thorough study of the processing schemes used at a plant for securing the most economical results.

TABLE 1

Tetraethyl Lead Required to Raise Octane Number of Typical Gasolines Containing Variable Amounts of Mercaptans or Disulfides

Disulfide or Mercaptan Sulfur, Weight Percent	TEL Required to Obtain Research Octane Number of 79 cc/Gal.
A. Straight Run Gasoline:	
0.0000	1.53
0.0025	1.60
0.0050	1.70
0.0100	1.81
0.0300	2.20
0.0600	2.78
0.0950	3.00
Disulfide or Mercaptan Sulfur, Weight Percent.	**TEL Required to Obtain Research Octane Number of 86 cc/Gal.**
B. Thermally Cracked Distillate:	
0.0000	1.61
0.0025	1.70
0.0050	1.76
0.0100	1.88
0.0300	2.22
0.0500	2.60
0.0950	3.00

TABLE 2

Differences in Tetraethyl Lead Requirements for Gasolines Sweetened by Conversion and Extraction Methods

	CONVERSION PROCESSES		EXTRACTION PROCESSES			
	Disulfide Sulfur, Weight Percent	Research Octane Number	Mercaptan Sulfur, Weight Percent	Research Octane Number	Octane Number Increase	TEL Savings cc per Gal.
Straight Run Gasoline A	0.065	79.1	0.002	82.4	3.3	1.4
Straight Run Gasoline B	0.017	82.4	0.001	83.3	0.9	0.5
Thermal Gasoline	0.031	87.2	0.003	88.5	1.3	0.8
Polyform Gasoline	0.030	92.0	0.002	92.3	0.3	0.3

REFERENCES

[1]Baker, J. J., O. & G. Jrl., Mar. 17, 1952, 306-9, 316.
[2]Kalichevsky, V. A., Petroleum Refiner, 29, No. 11, 97 (1950).
[3]Mapstone, G. E., Petroleum Refiner, 31, No. 2, 132-3 (1952).

TABLE 3

Sulfur Distribution for a Typical Refinery

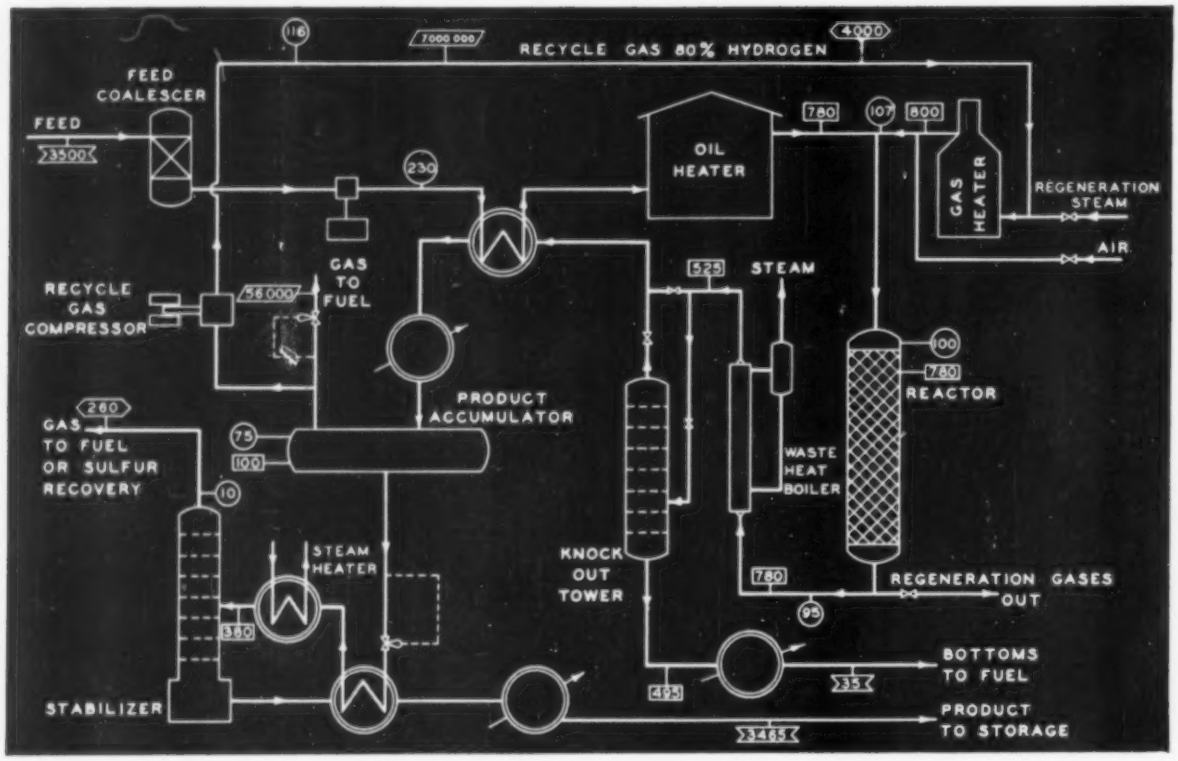
PRODUCT	Sulfur in Products Percent Weight in Crude Oil
Gas and Loss	18
Gasoline	7
Distillate Fuel Oils	18
Residual Fuel Oils	57
	100

TABLE 4

Sulfur Distribution for a Typical Catalytic Cracking Process

PRODUCT	Sulfur in Products Percent Weight in Charge Stock
Gas	33
Gasoline	4
Naphtha	1
Distillate Fuel	26
Heavy Gas Oil	36
	100

Desulfurization Symposium



Processes to choose from . . .

1. Autofining

Anglo-Iranian Oil Company, Ltd.,
London

Application. Autofining is a catalytic process for the desulfurization of high sulfur distillate feedstock which does not require an external source of hydrogen.

Charge. Straight run distillates up to 700 F. end point also aromatic extracts and blends with cracked distillates.

Product. With almost complete desulfurization the light products show an increase of 2-4 octane numbers (clear) and a greatly increased lead response. Under appropriate conditions 90 percent desulfurization can be obtained with straight run gas oil feedstocks.

Description. The accompanying flow diagram is that of an Autofining unit designed to handle solvent naphthas and power kerosines. The feedstock and the recycle gases are vaporized and heated in separate heaters and pass downward through the reactor. The hot vapors from the reactor pass through a waste heat boiler, where steam is generated; after heat exchange and cooling, the products flow to the separator from which the recycle compressor takes suction. If it is desired to meet a color specification with products such as power kerosines, the products leaving the waste heat boiler pass into the knock out tower where 1 to 2 percent volume of heavy ends are removed. Any excess gas make is passed to fuel from the product separator. Liquid product from the separator passes to a flash tower stabilizer to remove the hydrogen sulfide and other gases, which results in flash point rectification. The stabilizer product is normally free of hydrogen sulfide but a light caustic soda wash may be advisable to guard against poor stabilizer operation.

Granular (2 to 4 mesh) or pelleted catalyst is used and a life of over 12 months has been obtained. Regeneration of the catalyst can be readily accomplished by air/steam or inert gas/air mixtures when the full activity of the catalyst can be restored.

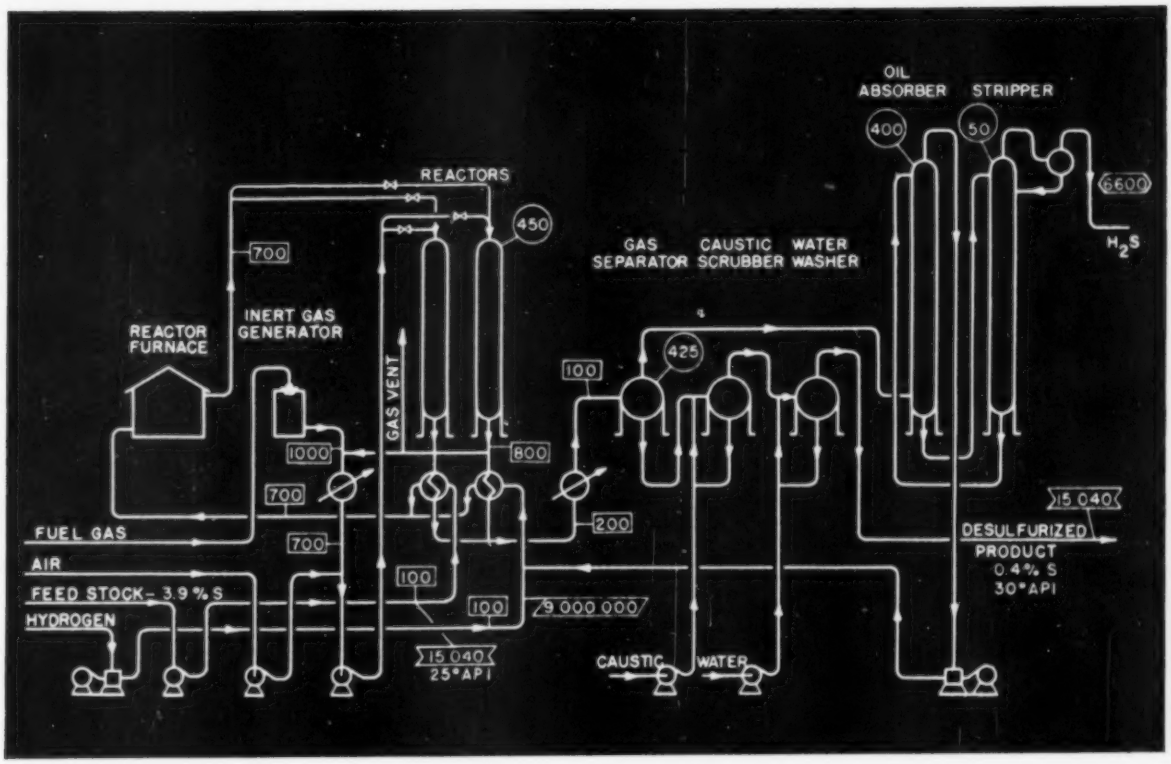
Operating Conditions. The process variables are temperature, pressure, space velocity and gas recycle rate; the most important being the space velocity. The usual operating temperature range is 750-800 F. Pressures may be held at 100-200 psig by venting excess recycle gas, or allowed to reach equilibrium in the system when the pressure may rise to 600 psig.

Yields. Typical yields and properties when operating on Middle East feedstock are shown in the table below.

	Power Kerosine Including 10 Percent Cat. Cracked Component		Straight Run Gas Oil	
Method of Operation	Constant Pressure (100 psig.)		Equilibrium Pressure (500 psig.)	
Yield:				
(Weight Percent on Feed)	99.0		96.0*	
Sulfur Removal Percent	70.0		92.0	
	Feed	Product	Feed	Product
°A.P.I. at 60 F.	39.6	40.2	36.3	38.0
I.B.P., F.	284	291	482	360
E.P., F.	502	500	684	671
Percent Sulfur	0.8	0.24	1.25	0.1
Octane Rating (F2) Clear	52	53	.....	.....
Diesel Index	.....	.....	60	60

* 1.4 Percent Weight Light Ends not Included.

Commercial Installations. The initial pilot plant built in 1948 at the Grangemouth, Scotland, refinery has been increased to a 500-barrel-a-day production unit, and a 3500-barrel-a-day unit has been in operation at the Llandarcy, Wales, refinery since July, 1952. A further unit is under construction at AIOC's Aden refinery.



Processes to choose from . . .

2. Unifining

Union Oil Company of California,
Los Angeles

Application. The process represents a versatile method of sulfur removal capable of handling all types of petroleum distillate stocks encountered in normal refining operations.

Product. Cracked gasoline stocks containing 3 percent by weight sulfur have been treated to give products of as low as 0.01 percent by weight sulfur with 100 volume percent yields.

Description. The accompanying diagram presents a simplified process flow for a unit to handle coke-still distillate of about 4.0 percent sulfur content and containing approximately 30 percent of material distilling in the lubricating oil range. Referring to the diagram, the feed stock and hydrogen are preheated by exchange against the hot reaction products. The exothermic heat of reaction is of sufficient magnitude to make the process independent of the preheat furnace except during start-up periods. The catalytic treatment may be conducted over a wide range of temperatures, but for maximum yield and desulfurization, a temperature in the neighborhood of 800 F. is employed. The reaction products after exchange with the feed are cooled and passed to a separator. The liquid product from the separator may be caustic-washed to remove traces of dissolved hydrogen sulfide and then sent to storage. The gas from the separator, containing hydrogen, hydrogen sulfide and small amounts of hydrocarbons, is treated in an oil absorption unit at the reaction pressure and the separated hydrogen recycled to the reactors.

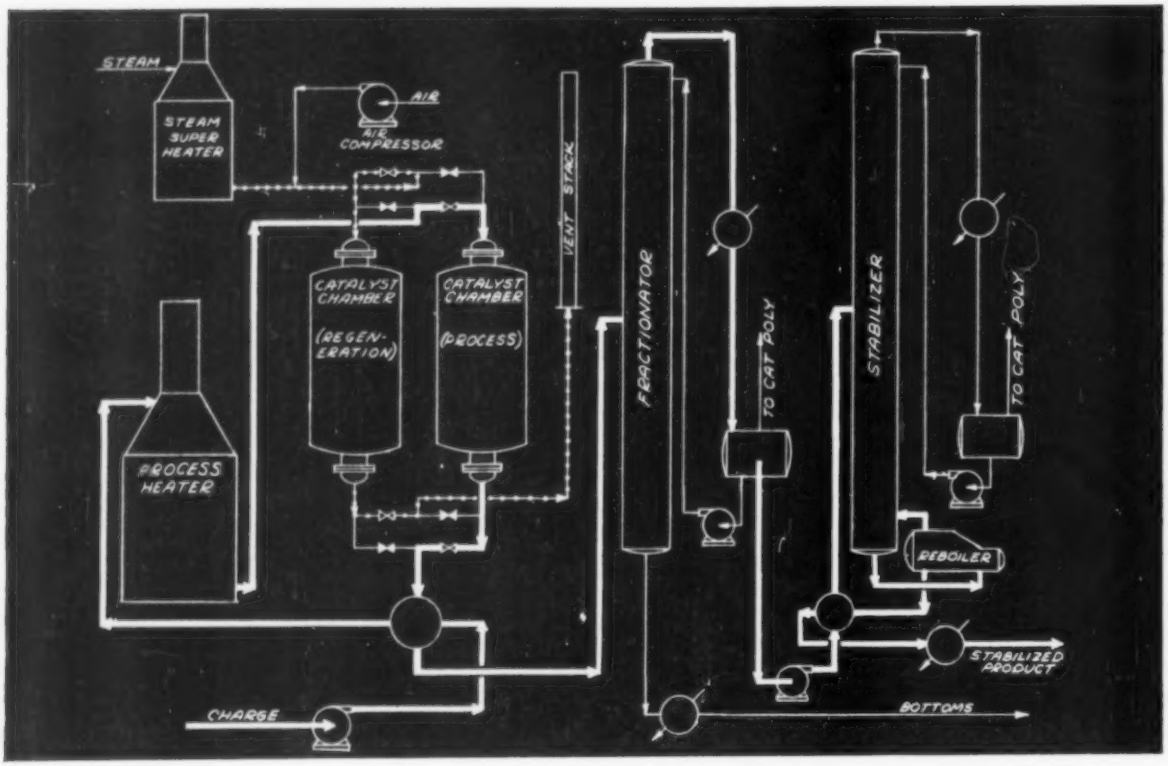
For the treatment of coke-still distillate, a multiple reactor construction is employed, three reactors being on stream while the fourth is being regenerated. Regeneration of the catalyst is accomplished in the conventional manner by adding air to a stream of inert combustion gas circulated through the catalyst bed.

The depletion of low sulfur content crudes in the U. S. is forcing refiners to employ increasing amounts of high sulfur content, low quality crudes of which there are considerable reserves. As the amount of high sulfur stocks processed increases, the proportion of refractory thiophenes and thiophanes, largely unaffected by present treating processes, also is increased, and a definite need is arising for a more effective means of desulfurization such as this process.

Yields. The table below illustrates the desulfurization of coke-still distillate.

	Feed, Heavy Coker Gas Oil	Gaso. Frac. of Product	Gas Oil Fraction of Prod.
Yield, Percent by Volume Based on Feed		8.4	91.2
Gravity, °API at 60 F.	19.4	47.7	26.1
ASTM Distillation Temp., °F.:			
Initial	482	164	480
10 Percent	584	238	498
50 Percent	699	320	612
90 Percent		372	
Maximum	760+	392	760+
Recovery Percent	72.5	98.0	91.0
Sulfur Content, Percent by Weight	4.2	0.1	0.5
Acid Solubility, Percent by Volume	100.0	37.5	50.0
Knock Rating, CFR Motor Method:			
Clear		64.5	
3.0 ml TEL/Gal.		76.5	
Viscosity, SUS at 100 F.	84		55
Pour Point, F.	65		45

Desulfurization Symposium



Processes to choose from . . .

3. Cycloversion

Phillips Petroleum Company,
Bartlesville, Okla.

Application. Cycloversion is used 1) to desulfurize straight run and cracked gasolines, naphtha fractions and kerosines; 2) to reform straight run gasoline or naphtha and 3) to catalytically crack gas oil stocks.

Charge. Under desulfurization conditions the charge stocks can be either a full boiling range gasoline or a naphtha fraction. Various mixtures of cracked and straight run charge stocks can be processed in a combined operation.

Product. Catalytic desulfurization of the straight run or natural gasoline charge stocks results in no appreciable change in the composition of the treated product other than the reduction of sulfur content.

Description. The accompanying simplified flow diagram shows the basic equipment included in a Cycloversion unit. The heater and heat exchangers are of conventional design and serve to heat the feed stock to the desired temperature with a minimum of thermal decomposition. Two reactors are provided for continuous operation, i.e., one chamber is on process while the other is being regenerated. The rerun and stabilization facilities are also conventional in design.

Caustic washing facilities are generally provided to remove the H_2S formed when the sulfur compounds are decomposed.

The catalyst is cyclocel grade bauxite and is a natural occurring material. It has a life of 5000-20,000 barrels per ton when used in nonregenerative desulfurization units and 50,000-100,000 barrels per ton when used in regenerative units.

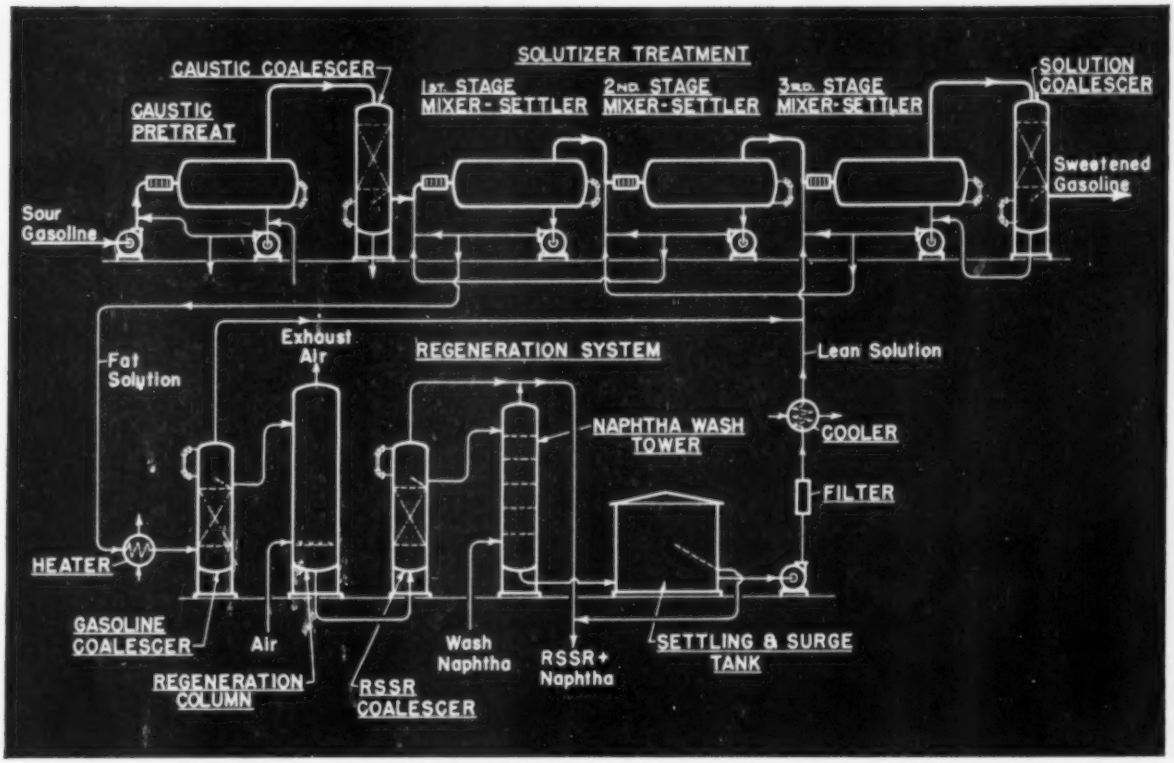
Operating Condition. The major process variables are temperature, pressure, and space velocity. Higher operating temperatures increase the depth of conversion. Lower pressures increase the olefinicity of the gasoline obtained from gas oil cracking, which, in turn, increases the octane rating of the product. Increasing space velocity at constant temperature and pressure decreases the depth of conversion.

Yields. In the desulfurization operation, the yields are 98.0-99.5 liquid volume percent of charge. Data for desulfurization operations which can be performed in this process are shown in the table below.

Commercial Installations. Forty-five units have been built and five are under construction. Of these, 23 are in desulfurization operation.

Catalytic Desulfurization

	Cracked Gasoline		50-50 Blend Cracked Straight Run		Straight Run Gasoline	
	Charge	Product	Charge	Product	Charge	Product
Operating Conditions:						
Space Velocity V/V/Hr.	.....	1.25	.....	1.0	.....	1.0
Cat. Chamber Inlet, F.	.....	758	.....	732	.....	803
Cat. Chamber Pressure, psig.	.....	35	.....	42	.....	50
Yield, Percent Charge	.....	99.5	.....	99.0	.....	99.6
Inspection Tests:						
Research Octane Ratings:						
Clear	72.2	75.6	61.4	67.2	64.2	66.3
Plus 1.0 cc TEL Gal.	78.4	82.4	70.0	76.6	71.5	76.6
Plus 3.0 cc TEL Gal.	82.8	87.3	77.9	83.7	78.1	85.5
Total Sulfur, Weight Percent.	0.225	0.178	0.088	0.024	0.123	0.004
Mercaptan Sulfur, Wt. Percent	0.011	Sweet	0.023	Sweet	0.049	<0.001
R.V.P., psig	6.1	6.8	9.9	10.0	11.1	10.7
API Gravity	56.3	56.0	66.2	65.9	64.6	63.9
Doctor Test	.....	.....	.....	.....	Sour	Sweet
ASTM Distillation, F.:						
First Drop	105	101	94	81	94	96
10 Percent Evap.	158	160	128	120	117	131
20 Percent Evap.	191	191	152	146	.....	.....
30 Percent Evap.	.....	.....	.....	.....	171	176
50 Percent Evap.	269	267	212	210	207	203
70 Percent Evap.	311	312	248	247	239	239
90 Percent Evap.	365	365	295	296	281	278
95 Percent Evap.	381	384	320	320	.....	.....
End Point	401	447	355	385	339	343



Processes to choose from . . .

4. Tannin Solutizer

Shell Development Company,
New York

Application. The Tannin Solutizer process is a cyclic process—removes mercaptans from sour gasolines.

Product. Mercaptan removal to the "odor sweet" level of 0.001 to 0.003 weight percent mercaptan sulfur is easily achieved when treating a wide range of straight-run or cracked stocks, either low-end-point or full-boiling-range gasolines.

Description. The three essential steps of the process are caustic pretreatment, solutizer treatment, and regeneration. Caustic pretreatment is often necessary to remove acidic components such as hydrogen sulfide and, in some cases, to control the alkyl phenol concentration. A single conventional mixer-settler arrangement is usually satisfactory for this purpose, and the caustic solution may be used until it is essentially saturated. A coalescer follows the caustic settler to minimize contamination of the potassium hydroxide treating solution with sodium ion.

For mercaptan extraction the sour hydrocarbon feed is contacted with a suitable solutizer solution in countercurrent flow. The solution may contain as solutizer either added fatty acids or naturally occurring alkyl phenols. The latter may be used if their concentration in the fraction treated is great enough to maintain the required solutizer strength in the treating solution.

A typical extractor consists of mixer-settler stages; however, other suitable contacting equipment, such as towers having either Raschig-ring packing or perforated trays, have been used. The treated hydrocarbon flows from the extraction section to storage or subsequent operations.

The spent treating solution is heated to 130 F., passes through a gasoline coalescer, and enters the regenerator where the extracted mercaptans are oxidized to disulfides by air blowing. This operation is accomplished in a column equipped with efficient air dispersers or in any standard liquid-gas mixing device. The regenerated solution is passed through a coalescer to remove entrained disulfide oil, and dissolved disulfide oil is removed by a simple countercurrent or batch naphtha wash. The naphtha required is only 1 to 2 percent of the gasoline treating rate, and it may be disposed of by adding it to reforming or catalytic cracking charge stock. The regenerated solutizer solution is then cooled and returned to the extraction step.

The extracting agent is a strong potassium hydroxide solution containing a small amount of tannin and mercaptan solubility promoters (solutizers) such as fatty acids; e.g., propionic and butyric acids and/or alkyl phenols.

A simple and flexible design, quite readily adaptable to utilization of existing equipment, characterizes this process. No corrosion-resistant metals are required as operating temperatures are low and the treating solution is noncorrosive. Labor costs are low due to simplicity of operation and adaptability to virtually complete automatic control. The solution is inexpensive and has an extended treating life, so that chemical cost is nominal. Exhaust steam can be used to fulfill the limited heating requirements.

Commercial Installations. Twenty-three built and four under construction.

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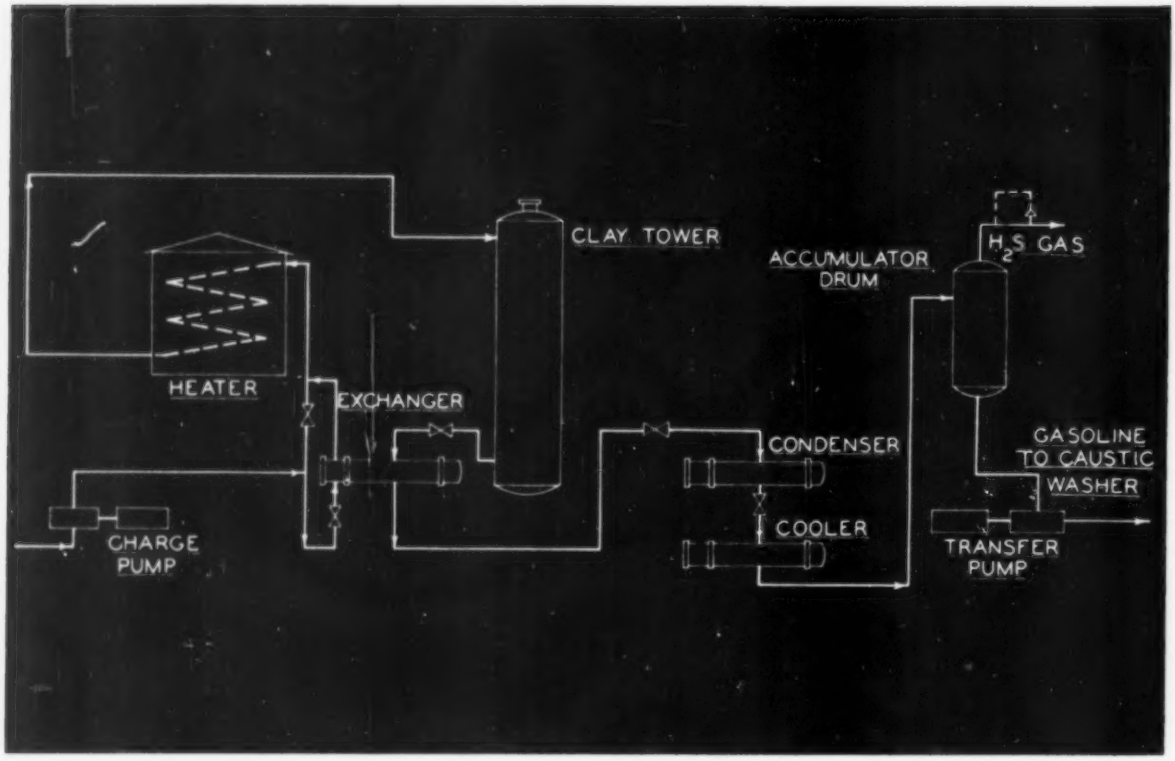


Processes to choose from . . .

5. Gray Desulfurization

Application. The Gray Desulfurization Process provides a method for removing undesirable sulfur compounds of both mercaptan and non-mercaptan types from lighter petroleum fractions.

Charge. Charge stocks comprise any straight run or cracked gasolines (or blends of the two) as well as kerosines and burning oil fractions boiling within the range of 425 to 600 F.

Product. The sulfur content of the gasoline is substantially reduced with practically complete removal of the mercaptan sulfur. An increase in clear octane number accompanies the desulfurization. At the same time, the lead susceptibility of the gasolines is increased. The burning quality of kerosines and burning oils is improved.

Description. The schematic flow diagram shown is typical of Gray Desulfurization installations. Desulfurization is effected by passing the vaporized fractions through a bed of catalyst at elevated temperatures. The pressure of operation is just sufficient to cause the vapors to flow through the catalyst bed and the auxiliary equipment. The equipment employed in the process is quite simple, consisting essentially of a heating coil, catalyst chamber and an accumulator drum together with the necessary pumps and tubular exchange equipment.

When charging cracked gasolines, it is desirable to employ an after fractionator (not shown in diagram) to remove the small amount of high boiling material formed during the treating operation.

Sulfur is removed from stocks in the form of hydrogen sulfide. Stabilization prior to caustic washing removes a substantial proportion of the hydrogen sulfide. However, auxiliary caustic washing equipment is required for its complete removal from the product.

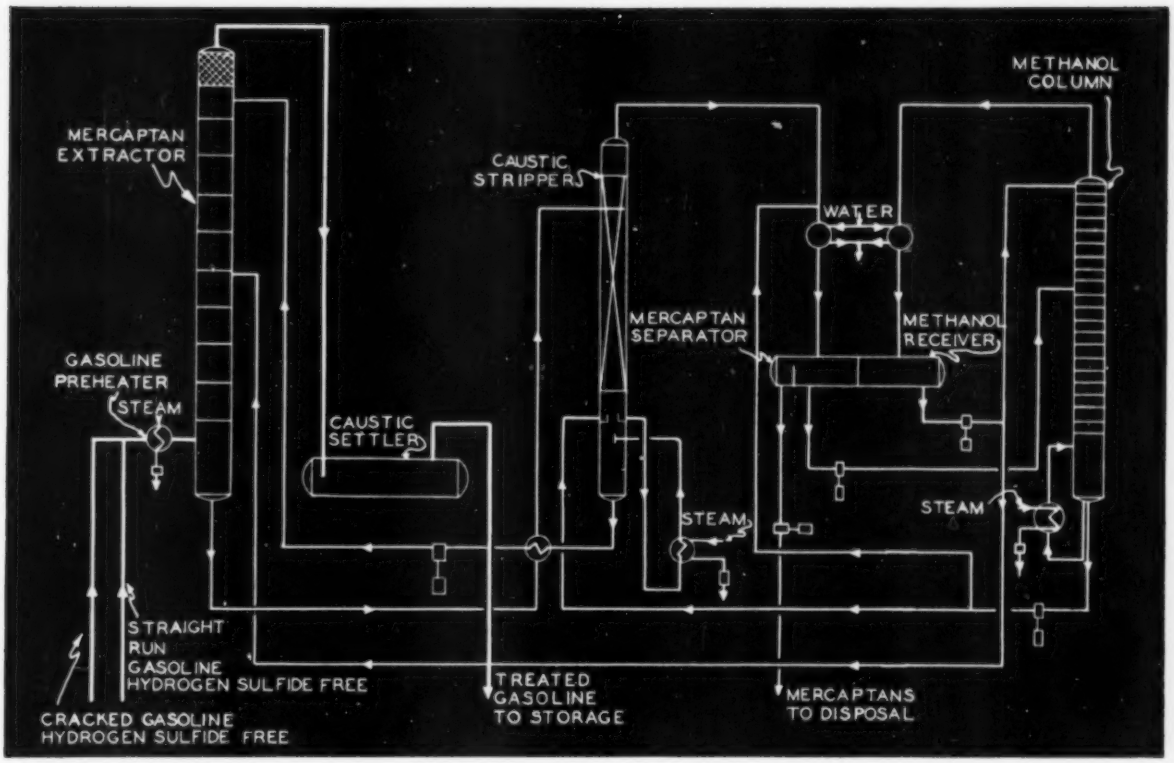
The catalyst employed in the process is of the solid adsorbent type such as Fuller's earth or similar materials.

Effective desulfurization has been obtained at catalyst ages of 5000 to 15,000 barrels per ton on straight-run gasolines, while for cracked gasolines, thruputs of 1200 barrels per ton may be realized provided the gasoline does not contain an appreciable quantity of diolefins. Substantial removal of mercaptan sulfur is obtained at thruputs of 5000 barrels per ton on kerosines and burning oils.

Operating Conditions. Desulfurization is effected at temperatures between 550 to 850 F. or higher depending upon the type of charge stocks and the degree of sulfur removal desired. Temperatures of 700 to 750 F. have been found most suitable for processing fractions from a wide variety of crude sources. Normally, the pressure of operation is less than 50 pounds per square inch.

Yields. The product yields from the desulfurization operation are high and average between 97 and 99 volume percent depending upon the sulfur content and the nature of the charge stock.

Commercial Installations. Eleven units have been installed for catalytic desulfurization by the Gray Process.



Processes to choose from . . .

6. Unisol Mercaptan Extraction

Universal Oil Products Company,
Des Plaines, Ill.

Application. The process extracts mercaptan sulfur compounds from gasoline and higher boiling petroleum fractions.

Product. Mercaptan reduction of better than 99 percent is readily accomplished by the process. Octane number improvements at the 3 cc tetraethyl lead level range from one to three or more points on the commercial plants, depending on the mercaptan sulfur content of the untreated gasoline. The magnitude of desulfurization possible is equal to the mercaptan present in the feed stock.

The treated product as it comes from the unit is usually sweet or nearly sweet. In almost all cases the product is completely sweet after a short time in storage, particularly in the presence of an inhibitor which has the unique property of accelerating air sweetening.

In comparisons of the properties of Unisol treated gasoline with the raw gasoline or with the product obtained by conventional sweetening, it is generally found that Unisol treating improves inhibitor susceptibility and lowers ASTM gum, and that copper-dish gums, after inhibiting, are considerably lower. Recently developed modifications enable the process to remove 95 percent or more of the mercaptans from distillates such as kerosine and domestic heating oil, thereby producing an oil with superior odor characteristics. Pyrrole-type nitrogen compounds are also removed by the process. Removal of sulfur and nitrogen compounds by Unisol treating markedly reduces color and sediment forming tendencies in distillate oils. Filter and burner tip plugging tendencies of domestic fuels, as determined by newly developed processes, are greatly reduced by Unisol treating.

Description. Hydrogen sulfide-free gasoline is introduced to the bottom of an extraction column and has mercaptans extracted from it as it flows upward in countercurrent contact with an aqueous solution of methanol and caustic soda. The caustic solution is introduced at the top of the extractor and methanol near the midpoint. Above the methanol inlet the caustic solution extracts any methanol dissolved by the gasoline from the caustic-methanol solution.

Treated gasoline is removed from the top of the extractor and sent to storage without any subsequent treating except addition of inhibitor. The fat caustic-methanol solution containing extracted mercaptans is withdrawn from the bottom of the extraction column and is charged to a caustic stripping column. In this column the methanol and mercaptans are stripped out leaving the caustic solution which is then withdrawn from the bottom of the column for re-use.

From the top of the stripping column, water-methanol-mercaptan vapors pass to a condenser. The condensed vapors then go to a mercaptan separator in which the extracted mercaptans separate from the water-methanol solution as an oily layer and are decanted from the system. The aqueous methanol solution is transferred from the mercaptan separator to a fractionating column from which methanol is recovered for re-use as an overhead product. Water from the bottom of this fractionating column is charged to the stripping column where it is evaporated to form stripping steam. There is no withdrawal of water from the system.

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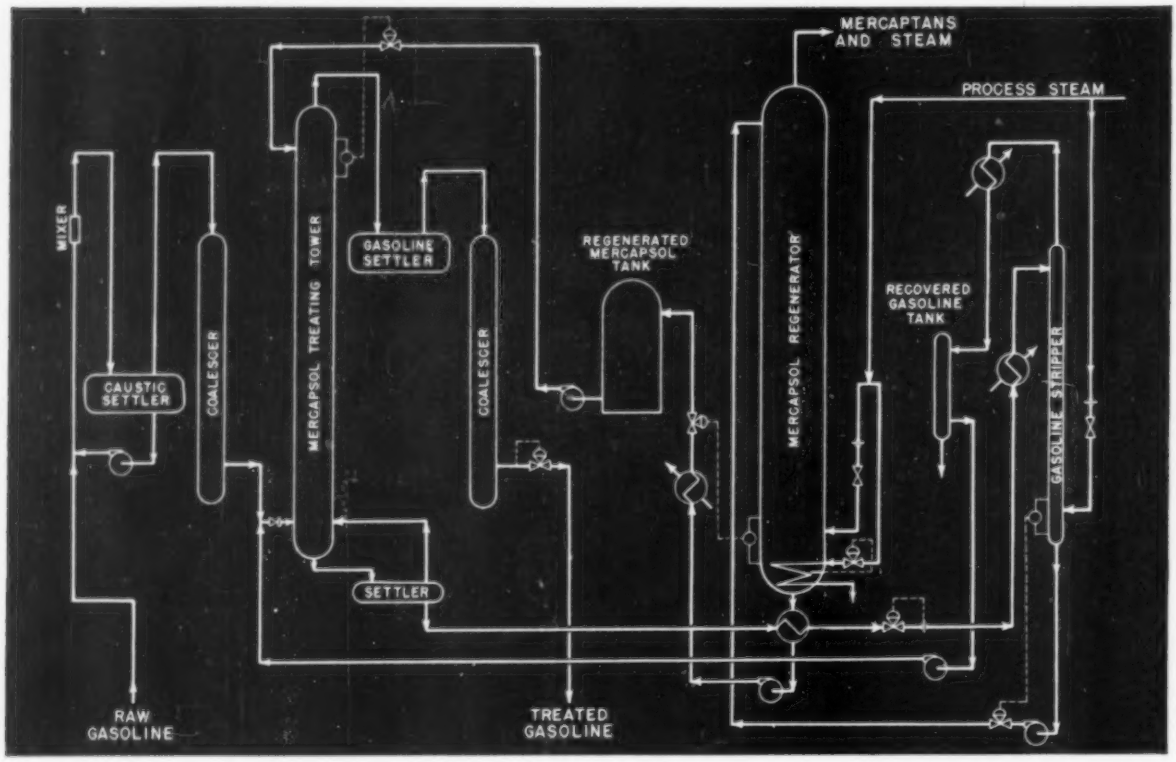


Processes to choose from . . .

7. Mercapsol Treating

The Pure Oil Company,
Chicago

Application. The Mercapsol treating process removes mercaptan sulfur compounds from gasoline thereby providing a method for meeting sulfur and odor specifications and for improving the lead susceptibility.

Charge. Mercapsol treating is especially attractive for use on straight run, thermally cracked or thermally reformed gasolines which are frequently very difficult to treat by other methods.

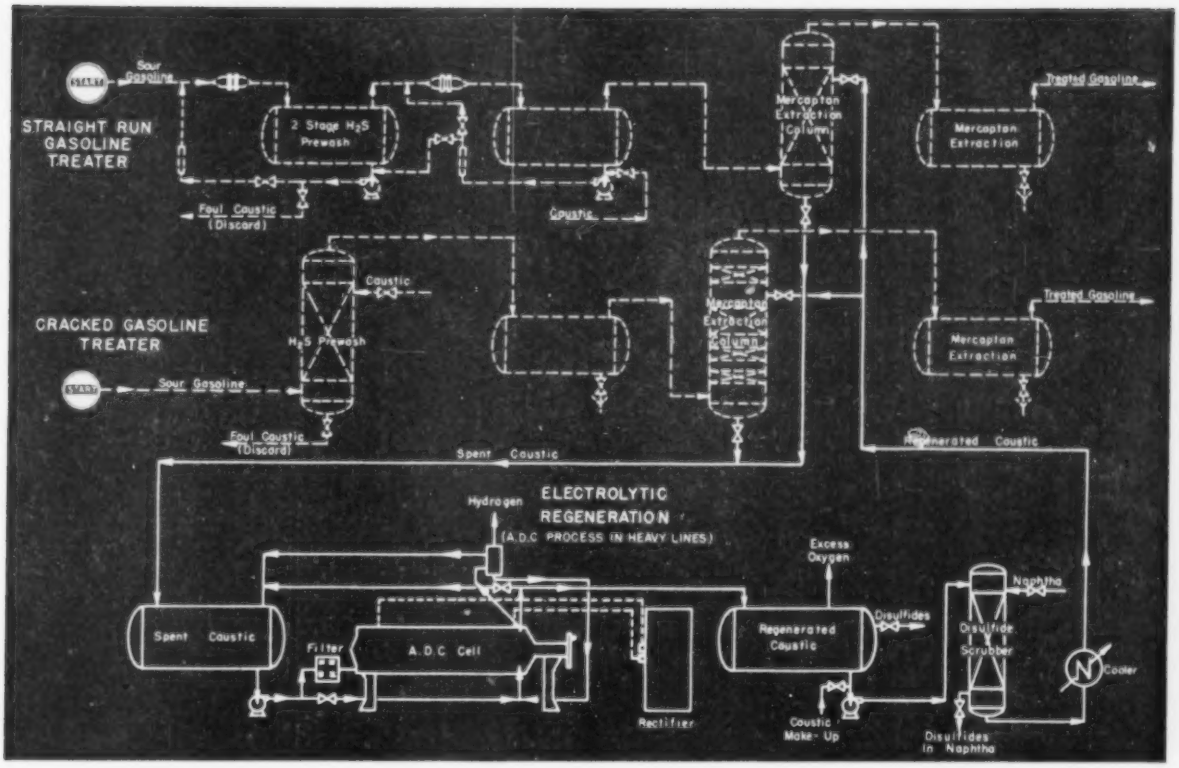
Product. In most cases a reduction in mercaptan sulfur content of 95 to 99 percent can be accomplished conveniently, and many gasolines can be extracted to doctor sweetness directly. In almost any case the use of a suitable gum inhibitor after Mercapsol treating will result in a doctor sweet product. Since mercaptans are actually removed from the gasoline instead of being converted to disulfides or other sulfur compounds, the product contains less total sulfur than the charge, and the process thus aids very materially in meeting sulfur specifications. Also by virtue of this decrease in sulfur content an improvement in the tetraethyl lead susceptibility of the gasoline is effected, and considerable savings in lead costs can be realized. This is one of the principal advantages of the process. The improved gum inhibitor susceptibility of the treated gasoline is an additional benefit.

Description. The operation of the process is illustrated by the flow diagram. Gasoline is treated in the liquid phase at ambient temperatures. Hydrogen sulfide and other acidic substances, which would otherwise build up in the permanent treating solution, are first removed by contact with low strength caustic solution. The gasoline from this step passes through a coalescer whose function is to remove any aqueous phase which would contain sodium sulfide and other salts. The gasoline then enters the treating tower near the bottom, where it is intimately contacted countercurrently by the descending continuous phase of Mercapsol solution which effectively extracts the mercaptans. From the top of the treating tower the treated gasoline flows through a settler and a coalescer for clarification and on to inhibiting and storage.

Spent Mercapsol solution containing the extracted mercaptans is withdrawn from the bottom of the treating tower into a settler from which the gasoline that separates can return by density difference to the tower. The treating solution as it then flows from the Mercapsol settler contains a small amount of dissolved gasoline which is recovered and returned to the treating tower. Recovery of the dissolved gasoline is accomplished in a small stripper by the use of a small amount of steam which is sufficient for this purpose but not enough to strip much of the mercaptan present. The Mercapsol is then steam stripped of mercaptans in the regenerating tower, and after cooling is stored in the regenerated Mercapsol tank from which it is pumped to the top of the treating tower to repeat the cycle.

The Mercapsol treating solution is an aqueous solution of sodium hydroxide containing salts of certain acid oils which act as solubility promoters for mercaptans. With proper precautions against contamination and loss the solution may be used indefinitely.

Commercial Installations. Mercapsol treating is currently being used in two Pure Oil Company plants.



Processes to choose from . . .

8. Electrolytic Caustic Regeneration

American Development Corporation, New York

Application. Where caustic extraction is used to remove mercaptans, this process is applied to recover the spent alkali treating solutions.

Charge. Spent caustic solutions containing mercaptans resulting from treatment of sour gasolines and other petroleum hydrocarbons.

Description. As shown in the diagram, the process continuously regenerates electrolytically caustic soda or potash used in mercaptan absorption and returns it to the extracting columns. The diagram also shows a conventional caustic extraction process.

Spent caustic is charged from the extracting towers into the storage tank and then is pumped at ambient temperatures into the electrolytic cell. Nascent oxygen produced by the electrolysis of water in the caustic solution oxidizes the sodium mercaptides to disulfides which are removed from the treating solution by a settler or naphtha scrubber. Hydrogen is vented to the atmosphere from the catholyte caustic maintained merely for electrical contact.

The special-process equipment consists of a filter-press type electrolyzer, using 60 electrolytic electrode plates, through which the spent caustic soda solution is passed in parallel and regenerated using direct electric current supplied by a selenium rectifier (when AC is used as a source current).

The basic reaction consists of the oxidation of sodium mercaptides to disulfides by nascent oxygen generated by the passage of direct current through the plates of the electrolyzer:

$$2\,NaSR + 2H_2O \rightarrow R_2S_2 + 2NaOH + H_2$$

It is desirable that the spent caustic be substantially sulfide-free.

Operating Conditions. The major process variables are:

- Concentration of mercaptan sulfur in spent caustic solution.
- Rate of flow of anolyte spent caustic solution.
- Concentration of caustic in solution.
- Temperature of solution.
- Amperage applied per square foot of anode area.
- Residence time of anolyte.

As the process is conducted successfully at ambient temperatures, no heating or cooling facilities nor corrosion-resisting metals are required. The ambient temperatures also avoid the decomposition of mercaptides to sulfides and the resulting corrosion.

Yields. The process results in terms of mercaptan sulfur oxidized per kilowatt hour intake are determined by the major process variables listed under operating conditions. Yields are generally better with higher mercaptan concentration, higher caustic concentration and temperature, and longer anolyte residence time.

Commercial Installations. Four operating and one under construction in U. S., Canada, France and Saudi Arabia.

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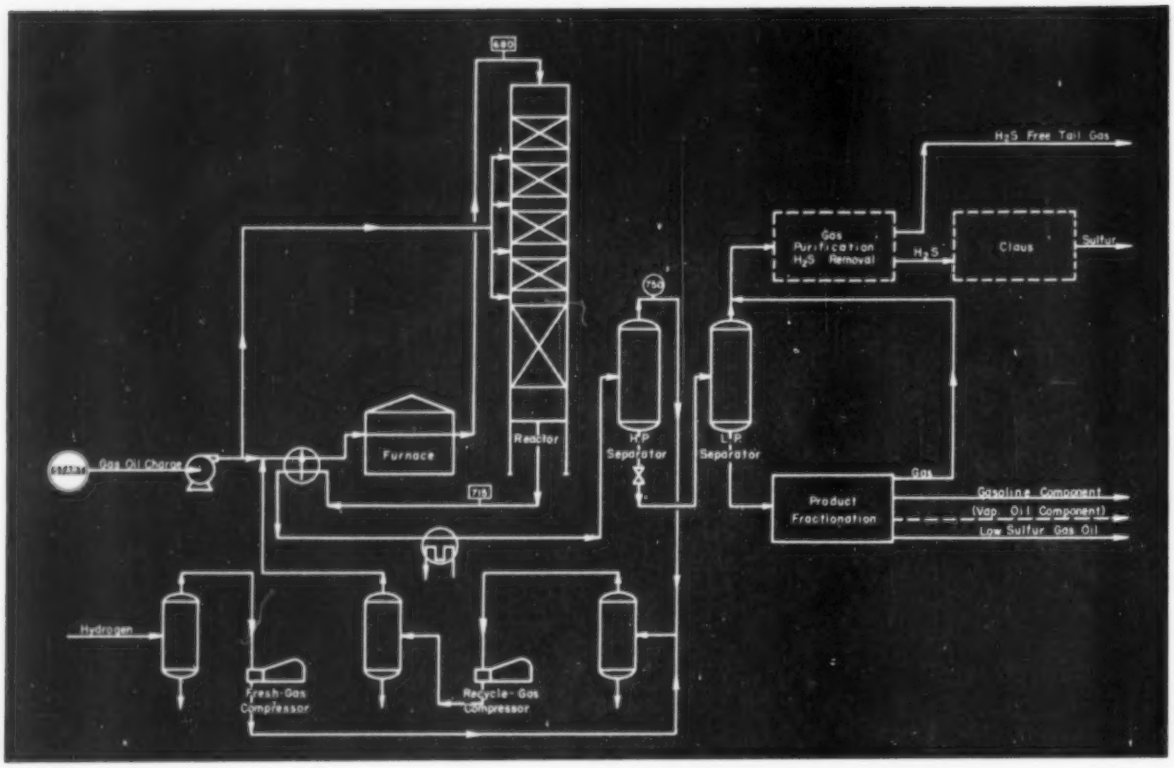

Processes to choose from . . .

9. Shell Hydrodesulfurization

Shell Development Company,
New York

Application. The process is used to remove sulfur from middle distillates by means of the reaction of sulfur compounds with a minimum amount of hydrogen.

Charge. Middle distillates such as straight-run and catalytically-cracked gas oils.

Product. A sulfur removal of 85 to 90 percent is obtained, a small fraction of high-octane gasoline being produced from the sulfur compounds.

Description. As shown in the diagram, the oil charge and fresh hydrogen, as well as recycle hydrogen, are combined. The combination is first preheated by exchange with hot reaction products, and then is heated in a small gas- or oil-fired furnace.

The reactor may contain a number of catalyst beds between which cold charge oil is injected to take up the heat produced in the exothermic hydrogenation reactions. The number of beds required depends upon the sulfur and olefin content of the charge stock and upon the degree of sulfur removal desired. With low-sulfur stocks, i.e., stocks with a sulfur content of, say, approximately 1 percent by weight or less, intermediate cooling may be omitted. The reaction products, after heat exchange with the feed, are cooled further and then passed to the high-pressure separator—from which, after the addition of makeup hydrogen, the gas is recycled. The liquid from the high-pressure separator is flashed in a low-pressure separator, and is then passed to a product fractionating section for removal of the remaining hydrogen sulfide and light ends.

If desired, an engine-fuel type of kerosine component may be recovered. The low-pressure tail gas may be passed to a gas-purification plant for removal of hydrogen sulfide, which may subsequently be converted to sulfur in a Claus plant.

For most commercial applications the rate of decrease of catalyst activity will be extremely low, corresponding to a catalyst life of the order of one year.

Operating Conditions. The process can be operated at pressures ranging from 300 to 750 psia and at temperatures from 660 to 730 F. The preferred operating conditions for deep desulfurization of middle distillates (80 to 90 percent sulfur removal) are 600 to 750 psia and 690 to 720 F.

Yields. The table below shows typical product properties for the hydrodesulfurization of a Middle East light catalytically cracked gas oil:

Processing Conditions:	
Catalyst	Cobalt-molybdenum-alumina
Pressure, psia	750
Temperature, Fahrenheit	710
Liquid Hourly Space Velocity, Vol. per Vol. per Hour	1.6
Recycle-Gas Rate, scf per Barrel	1350

		PRODUCT			
	Feed Stock	Fraction*: Under 430 F	Fraction*: 430 to 500 F	Fraction*: 430 F Plus	Fraction*: 500 F Plus
Percent Weight of Feed	100	9.9	20.3	87.6	67.3
Percent by Volume of Feed	100	10.7	21.3	90.4	69.1
Gravity, Deg. API	21.3	33.8	25.4	26.1	25.5
ASTM Distillation (Fahrenheit)					
Initial Boiling Point	446	270	437	475	532
End Point	650	417	480	650	650
Sulfur, Percent by Weight	2.90	0.01	0.02	0.34	0.43
Extractable with 98 Percent Sulfuric Acid, % by Wt.	70	87	80	.....	.....
Octane Numbers:					
ASTM, Without TEL Addition	.....	90	77	.....	.....
CFR Research, Without TEL Addition	.....	100+	88	.....	.....
Pour Point, Fahrenheit	14	.....	.....	19	25
Diesel Index	19.5	.....	.....	27.1	29.9

* Sharp Fractionation.

Commercial Installations. One under construction.

An auxiliary to petrochemical processing . . .

Tonnage Oxygen

◗ Part I. Rectification and Refrigeration

Part II. Heat Exchange Methods and Impurities Removal

Part III. "Package" Units.

Peter W. Sherwood, Chemical Engineer,
White Plains, N. Y.

THE IMPORTANT and growing uses for tonnage oxygen in the petrochemical industries were the subject of a recent paper in PETROLEUM REFINER.[1] It was pointed out that, in each case, the use of oxygen is merely one way of achieving a conversion which can also be accomplished by alternate means. The use of oxygen must, therefore, be predicated on competitive advantage. A controlling consideration are the economics of oxygen production which are intimately related to local power costs and to the required purity of oxygen.

To produce oxygen on the scale demanded by petrochemical operations, low-temperature fractionation of air is the only economically feasible process. Here, a fundamental distinction must be made between the production of liquid and gaseous oxygen.

Air separation for the recovery of highly purified oxygen and nitrogen in liquid form have been in operation throughout the world for nearly fifty years. The underlying processes are fairly well standardized and have acquired "classical" stature. These units serve to supply welding-grade oxygen (99.5+ percent) and nitrogen for such purposes as nitriding, calcium cyanamide production, etc. Liquid oxygen plants are in general of small capacity (5-50 tons per day) but they are numerous and their aggregate output in the United States amounted to 750,000 tons in the peak year 1944.[2] For special reasons (e.g. if oxygen is required at high pressures), large plants may also be designed for the production of liquid oxygen. One such installation is planned to yield 200 tons per day liquid oxygen for use at W. R. Grace and Company's ammonia plant which is under construction.

Expenditure of mechanical work is required for refrigeration and liquefaction of air. If the products of air separation are withdrawn from the plant in liquid form, none of the contained "cold" can be recovered for the refrigeration of incoming air. It follows that refrigeration requirements, and therefore power costs of classical oxygen plant are quite high.

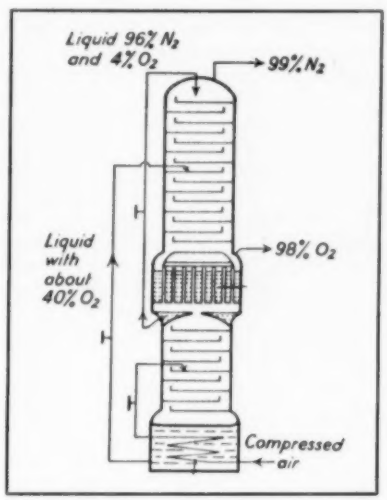

Figure 1. Linde double column.

The required work for refrigeration is supplied to the system by compression of gas (either air or, in some systems to be discussed below, nitrogen). To satisfy the large refrigeration demands of liquid oxygen plants, high operating pressures (120-200 atmospheres) are necessary.

A great deal of the refrigeration effect can be recovered by permitting the separation products to vaporize and to be warmed to ambient temperature in heat exchange with the incoming air stream. Cycles of this type consume, therefore, only a fraction of the energy demanded by liquid oxygen processes, and may be carried out at very much lower pressures (up to 6.5 atmospheres).

Low-pressure processes for the production of gaseous oxygen are found to be particularly suitable if operated on a large scale (say 50 tons per day oxygen or more). Collectively, they are referred to as "tonnage oxygen" cycles. For reasons which will become apparent later in this discussion, most of these processes will yield oxygen of medium purity (95-98.5 percent). This is, however, no obstacle in presently known petrochemical application.

While not new in itself, the production of tonnage oxygen has found application in the United States only since the end of World War II (the first plant began operation in 1948). For various economic reasons, most of the early development of tonnage oxygen cycles was carried out abroad, notably in France and Germany. Present activity in this field is high. Despite the late start, there are today at least fourteen tonnage oxygen plants in operation or under construction in the United States. Thirty-three units were under construction in Europe and South Africa in 1952 alone.[2]

No less than ten American engineering firms offer operating cycles for the production of tonnage oxygen. Furthermore, much interest has been aroused in various English, French, and German processes. In this confusion of methods, only a few really different approaches can be discerned. A classification of cycles becomes possible on the basis of their principal component elements:

(a) Method of Rectification
(b) Method of Refrigeration
(c) Method of Heat Exchange
(d) Methods for the removal of minor impurities (carbon dioxide, moisture, acetylene).

A limited number of feasible methods is available for each of these operations. The following discussion will consider the known practicable approaches to each of these four main factors. Attention will be given to basic process principles, advantages and drawbacks of the different systems, the mode by which the various component elements may be and have been combind into workable oxygen cycles, and the main economic factors involved.

Tonnage Oxygen

Methods of Air Rectification

The average composition of air, the raw material for tonnage oxygen production, is listed in Table 1, together with the boiling points of its components at atmospheric pressure.

TABLE 1

Composition of Air

Component	Volume Percent	Atmospheric B. Pt. of Component, °K
Nitrogen	78.03	77.7
Oxygen	20.93	90.2
Argon	0.932	87.5
Carbon dioxide	0.03	195 (sublimation)
Neon	1.5×10^{-3}	27.3
Helium	5×10^{-4}	4.3
Krypton	1×10^{-4}	121.5
Hydrogen	5×10^{-5}	20.4
Xenon	1×10^{-6}	164.1

Note: The concentration of carbon dioxide is somewhat higher in industrial areas. Water vapor is present in the atmosphere in widely varying quantities, depending on climatic conditions. Other components to reckon with include methane, hydrogen sulfide, nitric oxide, and acetylene. Their concentration is variable.

For most practical purposes, air fractionation may be considered a two-component separation between nitrogen and oxygen. The situation is complicated somewhat by the presence of significant amounts of argon which exhibits a volatility intermediate between the two main components.

In normal design, air rectifying columns are provided with only two outlets and argon must leave the system with one, or both, of the main streams. If all the argon is concentrated in the bottoms (oxygen), the purity of the latter is necessarily limited to 95.7 percent. Presence of all of the argon in the overhead will limit purity of the nitrogen to 98.3 percent. Usual practice is to split the argon between the two product streams, the greater portion going overhead with the nitrogen stream.

In certain instances, it becomes necessary to remove argon from the system separately, either because its recovery is desired or because both oxygen and nitrogen must be of very high purity. In such cases, a sidestream must be withdrawn from an intermediate point of the main column and a separate column must be provided for the purification of argon. This special aspect will be considered later.

The relative volatility of the key components is sufficiently large to make the separation of air a fairly simple problem in distillation. Complication is introduced by the need to refrigerate and liquefy the gaseous feed and to operate with maximum "cold" economy.

The Compound Column

This is in effect a standard fractionating column, provided with stripping and enriching sections. It is incorporated into several commercial cycles (Elliott, Rescol, etc.). Precooled and partly liquefied air is fed to an intermediate plate of the column. The overhead is partly condensed and returned to the system as reflux. Boil-up is provided in the bottom of the column by heat exchange with an incoming stream.

This column has the advantage of permitting independent adjustment of the reflux ratio, thus giving it maximum flexibility and good thermodynamic efficiency.

The column itself may be operated at substantially atmospheric pressure. It is, however, necessary to provide reflux cooling by an external refrigeration cycle. In the Elliott process, the air feed to the system is provided at 1.4 atmospheres, and column pressure is 1.2 atmospheres. To provide the necessary refrigeration, nitrogen recycle must be compressed to 5.7 atmospheres. The total volume of this recycle actually exceeds the air flow by 25 percent. Similarly, the Rescol process, operating with air feed at 2.2 atmospheres, requires an external nitrogen cooling cycle equal in volume to 75 percent of the air feed.

The efficiency of fractionation is measured in terms of oxygen purity and of oxygen recovery, i.e., the moles of oxygen appearing in the bottoms product per 100 moles oxygen in the air feed. A study by Roberts[3] shows the effect of column variables on these performance factors. Thus, a column containing 20 theoretical plates will require a reflux ratio of 2.9 to obtain 95 percent oxygen in 90 percent recovery. To obtain 99.5 percent recovery, the reflux ratio must be raised to 3.12.

The optimum number of theoretical trays was found to be 17 for 90 percent oxygen recovery in 95 percent purity. Twenty-three plates are the reported optimum for 98.5 percent recovery. Tray efficiency in low-temperature fractionation is very high, and actual number of trays proposed for compound columns in tonnage oxygen plants is 19-24. The distillation unit of Elliott Company's 10-ton-per-day oxygen pilot plant is provided with nine 26-inch diameter bubble trays spaced 12 inches apart above the feed, and with ten 19-inch bubble trays spaced six inches apart in the lower section. Construction of the trays is conventional, using three-inch bubble caps and with the addition of entrainment separators on each tray.[4]

The Linde Double Column

This is the unit employed by the majority of useful cycles (Linde-Frankl, Kellogg, Oxyton). It is incorporated (sometimes in modified form) into all commercial tonnage oxygen plants presently existing in the United States.

A schematic drawing of a double column is shown in Figure 1. The main (upper) column is operated at substantially atmospheric pressure. The feed is provided at an intermediate tray and is obtained with a composition of approximately 40 percent oxygen from the sump of the auxiliary lower column. Liquid nitrogen is fed as reflux to the top plate of the main column. It, too, is obtained from the lower column and it has an oxygen content of 4 percent. Vapor in equilibrium with this phase contains only 1 percent oxygen and is withdrawn as nitrogen make from the top of the upper column.

The lower column receives the air feed at an intermediate plate. The compressed air, precooled externally to its saturation point, is introduced through heat exchange coils located in the sump of the lower column. In the course of its passage through this tubing, the air is largely liquefied, giving up its latent heat to vaporize the bottoms liquid (which contains 40 percent oxygen).

Reflux in the lower column is provided by heat exchange with the purified oxygen in the upper column. This exchange determines the minimum permissible pressure differential between the two column halves. For, to obtain transfer of heat from the condensing nitrogen in the lower column to the vaporizing oxygen in the upper column, it is obviously necessary that the nitrogen liquefaction temperature be higher than the boiling point of oxygen at upper column conditions.

With the upper column operated at atmospheric pressure, the bottoms (containing substantially pure oxygen) will boil at —182.9 C. This temperature corresponds to the boiling point of nitrogen at 3.6 atmospheres. This, then, is the minimum pressure at which the lower column must be operated to achieve the required heat exchange between the nitrogen of the lower section and the oxygen of the double column's upper half. (The minimum pressure differential is less if impure oxygen is produced.)

The work required to compress all the incoming air to 3.6 atmospheres is approximately 2.5 times the theoretical minimum energy requirements for air separation. The maximum thermodynamic efficiency of any cycle incorporating the double column is, therefore, inherently limited at 40 percent.

To provide a finite temperature differential, an even higher pressure must

be chosen for operation of the lower column. For the production of 99 percent oxygen a typical practical value is 5.6 atmospheres for the lower column and 1.20 atmospheres in the upper section. This corresponds to an oxygen temperature of —181.2 C and a nitrogen reflux of —177.3 C in the lower column. A lower column pressure of 4.1 atmospheres is adequate to yield oxygen of 85 percent purity. The double column has the advantage of making the necessary amount of reflux available without calling for an external refrigeration cycle.

A limited amount of control is possible by adjusting the relative reflux rates taken in the two halves of the column. To obtain high-purity nitrogen, a greater reflux rate is taken in the lower column. As a result the liquid nitrogen fed to the top of the upper section will be of higher purity and the quality of nitrogen vapor leaving the top of the column will be correspondingly improved. However, taking a high reflux rate in the lower column, the oxygen concentrate fed to the upper section will be of lower purity and the system's oxygen make will be affected adversely.

Conversely, the quality of product oxygen can be improved—at the cost of nitrogen quality—by reducing the reflux rate in the lower column.

The plate at which oxygen concentrate is fed to the upper column is of significant influence on the purity of product. By raising the point of entry, a richer oxygen make is obtained. As in the case of reflux adjustment, this variation will improve the quality of one product at the expense of the other.

A shortcoming of the double column is the existence, in the upper section, of a reflux ratio which substantially exceeds the minimum requirements for most operating purposes. This introduces a factor of irreversibility into column operation which results in significant loss in thermodynamic efficiency.

A significant development, due to Lachmann, permits this objection to be overcome when high purity is not required in both of the products. This invention which is used in the Kellogg and Linde-Frankl II. cycles takes advantage of the excessive amount of liquid present in the upper (atmospheric-pressure) column by injecting into it a stream of gaseous air which has been precooled to its saturation point. This permits additional oxygen production without increasing power expenditure for air compression. It can be shown that up to 44 percent of the total air can be injected into the upper half of a double column at ideal conditions.[5] The Lachmann feed is introduced at a point in the upper column at which the concentration of oxygen is 21 percent, i.e., the same as that of the air feed.

One effect of Lachmann air is that it provides better equilibrium between the liquid and vapor phases of the various trays. While this results in better thermodynamic efficiency, practical considerations defeat full utilization of this principle. In the Kellogg cycle, the amount of air injected directly into the upper column is reported to be approximately 30 percent of the total.

In American practice, the use of bubble-cap plates is the preferred construction, while sieve trays have found wide application in German and French double-column construction. The advantage of bubble-cap trays is, of course, their high efficiency over a wide range of distillation rates. Almost full effectiveness is obtained at 40 percent of capacity while sieve trays do not provide satisfactory performance below one-half of design capacity.

Individual tray efficiencies are very high. In the case of sieve tray construction, it has been reported to be 160 percent near the middle of the tower and 80 percent at the ends.[6] The rated superficial velocity is 1.2 feet per second in the main tower and 0.4 foot per second in the lower column.

Very small bubble caps (0.3 inches in diameter) are standard in the double columns constructed by Adolf Messer, G.M.B.H. Plates constructed with these caps can be spaced 2.5 inches apart. However, vapor velocities are somewhat lower than with sieve trays, being of the order of 0.6-0.8 foot per second. Trays of this design are characterized by very high efficiency, low pressure drop (1.5 to 2.2 psi through the 56-60 trays) and low sensitivity to load changes. The construction is, of course, more expensive than that of sieve trays.

Table 2 gives conditions which may be considered to be typical of double-column fractionation.

TABLE 2

Typical Operating Characteristics of a Double Column (Sieve-Tray)

	Lower Column	Upper Column
Pressures	5.2 atm. abs.	1.2 atm.
Temperatures (°C)		
Top	—182	—194
Bottom	—172	—185
Reflux Liquid		138,000 cu. ft. (liquid nitrogen)
Product (expressed as gas):		
Top	25,000 cu. ft. of nitrogen (liquid)	335,000 cu. ft. of nitrogen (gas)
Bottom	245,000 cu. ft. (mixed liquids)	86,000 cu. ft. (liquid oxygen)
Plates	24	36

The Oxyton cycle of L'Air Liquide and Air Reduction Company's version of the Linde-Frankl cycle employ a three-column modification of the Linde double column principle. The columns are operated at 5.5, 2.7, and 1.2 atmospheres (abs.), respectively. It is claimed that this mode of operation improves oxygen recovery over standard double-column performance. In this system,[7] the HP- and LP-columns work in a fashion similar to the double column. The medium pressure (MP) tower is interposed in the flow of oxygen-rich liquid. Thus, air is fed to the HP-tower where it is separated into liquid oxygen concentrate and gaseous nitrogen overhead. The oxygen-rich liquor flows to the LP-column, where it is further enriched before it is fed to the main column.

The gaseous nitrogen flow from the HP-tower leads to the top of the secondary column in heat exchange with the low-pressure nitrogen product. Reflux to the main column is provided by this stream together with a portion of the liquid nitrogen withdrawn from the vaporizer-condenser provided in the middle of the HP-LP double column.

Variants of the double column—the Claude dephlegmator or the Linde cocurrent vaporizer—may be used advantageously for the production of low-purity oxygen (60-80 percent). With a system using the Claude dephlegmator required initial air pressure is considerably lower than with a standard double column. For the production of 63 percent oxygen, a pressure of 3.0 atmospheres is adequate, while 3.8 atmospheres serve for the recovery of a 76 percent oxygen stream. Over-all energy savings are significant and make such a system desirable in installations where low-purity oxygen satisfies the requirements.

Methods of Refrigeration

Refrigeration is defined to describe any operating scheme whereby the temperature of a system may be reduced below that of its surroundings. In accordance with the second law of thermodynamics, this effect can be brought about only by the expenditure of energy.

Three different methods of refrigeration serve in air liquefaction processes: (a) low-pressure vaporization of a liquid, (b) irreversible gas expansion (Joule-Thomson effect), and (c) approximately reversible expansion of a gas with the expenditure of work.

Refrigeration by Low-Pressure Vaporization

This method takes advantage of the

reduction in the boiling point of liquids at lowered pressures. If a compressed vapor is condensed by heat exchange with an available medium, the resulting liquid may be evaporated at a lower temperature by reducing the pressure on the system.

With any liquid, this method of refrigeration is theoretically limited to an operating range extending from the triple point to the critical temperature. In practice, the permissible range is, of course, much smaller. By providing a sequence of suitably matched liquids, each of which goes through its own refrigeration cycle in heat exchange with the next-higher and next-lower boiling media, air or nitrogen can be readily liquefied. A typical cascade consists of the refrigerant series ammonia-ethylene-methane-nitrogen.

In tonnage oxygen cycles, low-pressure vaporization is repeatedly utilized. Examples include the flashing of nitrogen and oxygen concentrate from the high-pressure column to the main tower in Linde's double column. In the Elliott cycle an external refrigerant (e.g., freon) serves to pre-cool air to 15 C, mainly to reduce moisture content. Ammonia evaporation serves to refrigerate high-pressure air in the Linde-Frankl I. cycle, and thereby reduces the required initial pressure of this stream.

Refrigeration by the Joule-Thomson Effect

The Joule-Thomson effect is a change in temperature experienced during the irreversible adiabatic expansion of a gas through a nozzle. The magnitude and direction of the effect depends on the initial pressure and temperature. However, with all gases, other than hydrogen and helium, cooling will accompany expansion at all initial temperatures up to room temperature.

The temperature drop due to Joule-Thomson expansion is only small and does not exceed 50 C at any condition encountered in oxygen cycles. However, the effect may be made cumulative by proper coordination of expansion with heat exchange. For example, air may be expanded and the resulting low-temperature stream may serve to precool incoming air which, upon expansion, attains an even lower temperature.

For all pressures above 38.4 atmospheres, the Joule-Thomson coefficient reaches a maximum at some temperature which is a function of the pressure. For instance, the cooling effect of expansion from 40 atmospheres is greatest at —135 C, and exhibits a lower value at higher and at lower temperatures. Below the critical pressure of 38.4 atmospheres, the Joule-Thomson coefficient shows a steady increase with decreasing temperature.

The true measure of the efficiency of Joule-Thomson expansion is the cooling effect achieved by any given *ratio* of initial to final pressure since this ratio determines the amount of work required for compression. It can be readily calculated that the expansion becomes more effective if the final pressure is high.

The Joule-Thomson effect is wholly irreversible and suffers therefore from inherent low efficiency. Its principal advantage is the simplicity of equipment which it allows and its suitability for operation in the two-phase region. Its most important remaining application in the production of tonnage oxygen is its use for the liquefaction of the high-pressure auxiliary air stream in the Linde-Frankl I. cycle which is the most wide-spread single process in the industry.

Refrigeration by the Expenditure of Work

Considerable improvement in cooling effect over Joule-Thomson expansion may be obtained by making the expanding gas perform work, e.g., by driving a turbine or a reciprocating engine. The work made available in this manner may be used to reduce energy consumption elsewhere in the cycle.

Expansion conditions encountered in this operating method are more nearly reversible than in the wholly irreversible Joule-Thomson throttling, and the process is therefore inherently more efficient. The cooling effect of simple expansion is increased by an amount equivalent to the external work performed.

Expansion engines have been used successfully in the commercial production of liquid oxygen. Certain designs (e.g., the Heylandt liquefier) show efficiencies of the order of 75 percent in high-pressure operation. At lower pressures, these machines exhibit, however, thermodynamic efficiencies (due to mechanical shortcomings) which are not far superior to Joule-Thomson expansion. They are, furthermore, bulky and of expensive construction and are not feasible for the production of oxygen on the large scale demanded by the petrochemical industries. Much impetus was given to the development of low-pressure oxygen processes by the successful design of efficient turbo-expanders.

Several turbo-expanders have been used in commercial Linde-Frankl plants in Germany subsequent to 1936. These are simple radial impulse turbines rotated at such a velocity as to reduce the exit velocity of the air to nearly zero. With a 300-mm. pitch diameter, this calls for operation at 7000 rpm to attain a top speed of 377 feet per second at the conditions outlined below:[6,8]

Capacity	4,700 to 12,500 pounds per hour nitrogen
Inlet pressure	5 atm. abs.
Discharge pressure	1.2 atm. abs.
Inlet Temp.	—145 C.
Discharge Temp.	—170 C.
Efficiency, percent	53.5

Very much better efficiencies (of the order of 78-83 percent) can be obtained with turbo-expanders which have been developed in the United States since 1942.[8]

Turbo-expander performance is improved somewhat as the air capacity is raised. For any given capacity, a sharp maximum efficiency is obtained at the optimum wheel diameter. Availability of turbo-expanders operating at efficiencies in the range of 80 percent permits elimination of the high-pressure air cycle which complicates the Linde-Frankl I. process (which will be discussed in a subsequent section). The entire refrigeration requirements may be covered by expansion of a stream of medium-pressure air (at 5-6.5 atmospheres) into the upper part of a double-column via a suitable turbo-expander.

While this method of operation characterizes several of the modern tonnage oxygen cycles, Karwat[9] points out that it is subject to severe limitations. As the amount of air fed to the upper column (i.e., Lachmann air) increases, it becomes more and more difficult to obtain pure nitrogen, and oxygen recovery is correspondingly depressed. For instance, an increase in overhead oxygen concentration from 3 to 6 percent results in a loss of 14 percent in oxygen recovery.

To compensate for this, more air must be handled, greater heat losses are accordingly incurred, more refrigeration is required, and a vicious circle is thus established.

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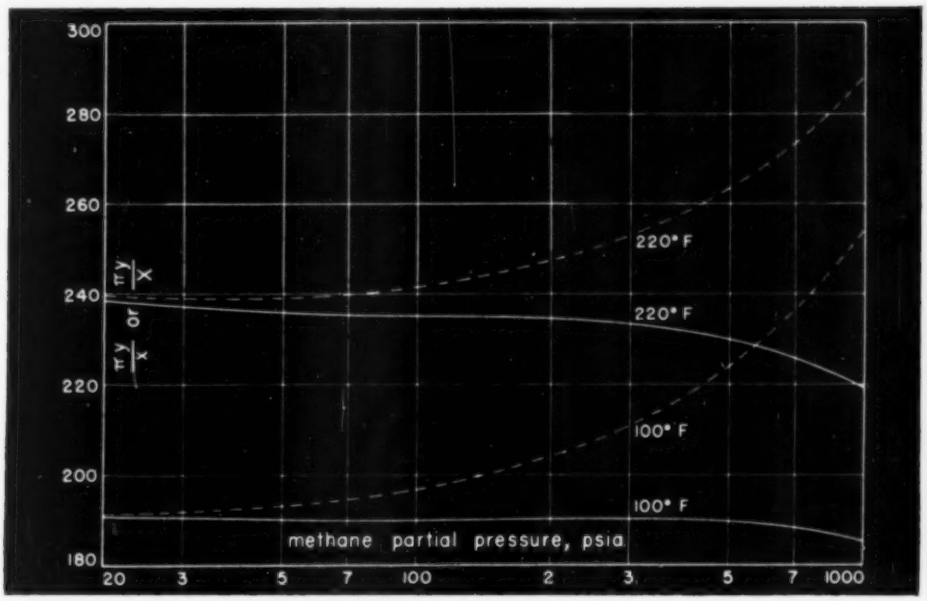

Figure 1. $\cdots = \frac{\pi y}{x}$ and $= \frac{\pi y}{X}$ as functions of methane partial pressure system: methane-decane. Ind. Eng. Chem. 34, 1526 (1942).

Applying Henry's Law to . . .

Concentrated Gas-Solvent Systems

By the development of mathematical relations for the equilibrium constant, the applicability of Henry's Law is extended to solutions of high concentrations.

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WHEN WORKING with equilibrium data, Henry's law gives much better results in the regions of low solute concentrations than it does in regions of high solute concentrations. Development of mathematical relations for handling these systems of high concentrations, which are frequently found in industry today, give the designer a much improved tool with which to work. The expressions developed help to anticipate the deviations from the basic assumptions of the Henry's law equation.

Basic Equations Expressing Henry's Law—In 1803 Henry,[3] after determining the solubility of a number of relatively slightly soluble gases in water, wrote: ". . . under equal circumstances of temperature water takes up the same volume of condensed gas as of gas under ordinary pressure." In the same article he rephrased this statement as follows: ". . . water takes up, of gas condensed by one, two, or more additional pressures, a quantity which, ordinarily compressed, would be equal to twice, thrice, etc., the volume absorbed under the common pressure of the atmosphere. By frequent repetition of the experiments, I obtained results differing a little more from the general principle above stated; but, for all practical purposes, I apprehend, the law has been announced with sufficient accuracy." In current terminology the statements would be exactly expressed mathematically as follows:

$$v = k'p. \qquad (1)$$

In the light of present knowledge it is immediately recognized that Equation (1) assumes unity compressibility factor of the gas over the pressure range under consideration. Equation (1) may be rewritten in terms more consistent with modern practice, as follows:

$$p = H'X. \qquad (2)$$

In recent literature, however, the Henry's law expression has frequently been written as follows:

$$p = Hx. \qquad (3)$$

Equation (3) has often led to the expression of the Henry's law constant as the atmospheres partial gas pressure per mole fraction of solute in solution. Again, on the assumption that the ideal gas laws are valid, i.e., that

$$p = \pi y, \qquad (4)$$

the statement has been made that Henry's law provides that, at a given temperature and total system pressure, the ratio of y/x is constant for that gas component which follows the law.

In connection with such an expression, it is usually also found that constancy can normally not be assumed to hold above x values of 0.01 mole fraction.

Modifying Basic Equations to Handle Concentrated Gas Solution Systems—It is becoming increasingly important to be able to handle, mathematically, the equilibrium relations involved in certain more concentrated gas solutions frequently encountered in modern industry, i.e., in those instances where the original Henry expression, Equation (2), holds, but where x differs significantly from X and where Equation (3) does not hold.

Assuming Equation (4) to be valid, Equation (2) may be rewritten as follows:

$$\pi y = HX. \qquad (5)$$

Equation (5) may also be written in the activity coefficient form, as follows:

$$\pi y = \gamma' PX. \qquad (6)$$

Equation (6) inherently assumes the effective vapor pressure of the component gas to be independent of the system pressure.

Though Equation (5) employs an unusual combination of terms, it is fundamentally correct for those systems which follow the basic Henry's law principle. The Henry's law constant may then be expressed as the atmospheres partial pressure of component in vapor per mole ratio of that component in solution. Equation (5) also suggests use of an equilibrium constant, $K' = y/X$. However, such is not convenient in most of the currently used equations. It therefore becomes necessary to evaluate the conventional equilibrium constant, $K = y/x$, for those systems which follow Equation (5). This may be done very simply from the definitive equation,

$$x = \frac{X}{X+1}. \qquad (7)$$

Thus we may write

$$\frac{y}{x} = \frac{y(X+1)}{X}, \qquad (8)$$

and

$$\frac{y}{x} = K = y + \frac{y}{X}. \qquad (9)$$

Or, by combining the definitive equation,

$$X = \frac{x}{1-x}, \qquad (10)$$

with Equation (5) we obtain the following:

$$\frac{y}{x} = K = y + \frac{H'}{\pi}. \qquad (11)$$

Equation (11) may be written in the activity coefficient form by using the definition of γ' from Equations (6) and (5).

$$H' = \gamma' P. \qquad (12)$$

Thus,

$$\frac{y}{x} = K = y + \frac{\gamma' P}{\pi}. \qquad (13)$$

Or, since it is often convenient to evaluate y/x directly from gas solubility data in terms of the Bunsen solubility coefficient, α, and noting that, on the assumption of unity compressibility factor,

$$X = \frac{\frac{(p)(\alpha)}{V}}{\frac{\rho}{W}} = \frac{(\pi)(y)(\alpha)(W)}{(\rho)(V)}, \qquad (14)$$

we obtain from Equation (9) the following:

$$\frac{y}{x} = K = y + \frac{(\rho)(V)}{(\pi)(\alpha)(W)}. \qquad (15)$$

From Equations (11) and (15) can be derived the expression for H′ in terms of the Bunsen solubility coefficient, as follows:

$$H' = \frac{(\rho)(V)}{(\alpha)(W)}. \qquad (16)$$

Similarly, the value of H for combined Equations (3) and (4) becomes

$$H = \pi y + \frac{(\rho)(V)}{(\alpha)(W)}. \qquad (17)$$

Analytically, Equation (17) shows that, for H to be essentially constant over a range of concentrations of solute in solvent, α must, in general, be small relative to (πy). Conversely, H will not remain essentially constant over a range of concentrations of solute in solvent if α be large relative to (πy). Equation (16) involves no such expression and thus shows H′ to be independent of component partial pressure within the limits of the assumptions.

That there exist systems which follow Equation (5) and for which α is relatively large has been evidenced for many years. However, the tie between that knowledge and certain contemporary plant designs and operations has frequently been omitted. For example, for systems following Equation (5), the variation of equilibrium y/x from top to bottom of an isothermal, isopiestic absorption tower may be predicted by calculation, as will be illustrated later.

The Acetylene-Acetone System—The acetylene-acetone system is the classic example of one which follows Equation (5) over relatively wide temperature and pressure ranges. As early as 1897 Claude[2] write, ". . . the volume dissolved increases almost proportionally with pressure." Berthelot[1] demonstrated that, over the acetylene partial pressure range extending from 1 atmosphere absolute to 20 atmospheres absolute or more, the weight of acetylene dissolved per unit weight of acetone is nearly linear with acetylene partial pressure over a wide range of temperature. For example, Berthelot found that, at 10, 20, and 30 C., the solubility of acetylene in acetone, in mole ratio units, differed from a linear relation, with pressure, by a maximum of only 6 percent over a range extending to a maximum of 0.644 g. acetylene per g. acetone. At this maximum value X has a value of 1.44 and x a value of 0.59. This linearity has been further confirmed by Copley and Holley,[3] who state that, at 15 C. and an acetylene partial pressure of 1 atmosphere, the equilibrium acetylene concentration in the acetone solution is 0.071 mole fraction; at 12 atmospheres it is 0.490 mole fraction. These concentrations correspond to X values of 0.080 and 0.961, respectively. It is noteworthy that the two values of X are in the ratio of the acetylene partial pressures, whereas the values of x are not. Thus there is quite a large concentration range over which the approximately linear relation holds for X. The phenomenon is utilized by the acetylene bottling industry, which has found that the amount of acetylene which an acetylene cylinder will contain at a stated temperature is approximately proportional to the absolute pressure of acetylene in the cylinder.

Plotting Equilibrium Data for Concentrated Gas Solution Systems—Over large ranges of concentrations many systems will probably be found to follow the true Henry's law relation only approximately. For such systems it is proposed that the commonly used plots for $K = y/x$ vs. π (at constant temperature), or vs. temperature (at constant π), be replaced by plots of ordinates of p/X or γ' vs. abscissae of p or log p at constant temperature. The curves thus obtained will be nearly straight lines with less slope than the corresponding plots of p/x or γ vs. abscissae or p or log p. From p/X values, y/x can be calculated by a modification of Equation (9):

$$\frac{y}{x} = y + \frac{p}{\pi X} \qquad (18)$$

If a system followed Henry's law exactly, the lines would be straight and horizontal.

It has been known that the solubilizing of gases by solvents is often attended by association effects. The degree of departure of plots of p/X or γ' vs. p from straight horizontal lines,

to the extent that it is not due to gas compressibility effects, is a measure of the change of degree of association.

Effect of Association Between Solute and Solvent—This may be illustrated by available data for the acetylene-dimethylformamide system[4] at 0.1 atmosphere and 1.0 atmosphere partial pressure of the gas, which show the following at 77 F.

TABLE 2

	$\frac{p}{X}$	$\frac{p}{x}$	γ'	γ
Value at 1.0 atm.	9.96	10.98	0.2060	0.2274
Value at 0.1 atm.	9.06	9.17	0.1874	0.1895
Ratio	1.10	1.20	1.10	1.20

Even in this instance values of p/X and of γ' showed less variation over the ten-fold pressure range than did the corresponding values of p/x and γ. I.e., the system followed Equation (2) more closely than it did Equation (3).

It is significant to examine the effects on values of y/x which might result from operation of an absorber employing dimethylformamide to absorb acetylene from a mixture. We might, for example, assume an absorber operating at 10 atmospheres absolute and 77 F., to which is fed a gas containing 10.0 percent acetylene. We will assume that the gas leaving the top of the absorber contains 1.0 percent of the same constituent. We will further assume that the other constituents of the gas mixture are insoluble in the solvent. From Table 2 and Equation (18) the following values are obtained for $K = y/x$ at bottom and top of the column:

Bottom: $y/x = 0.100 \div 9.96/10 = 1.096$
top: $y/x = 0.010 \div 9.06/10 = 0.916$

Had the solubility data at atmospheric pressure been the only data available, and had it been assumed that the system followed Equation (2), y/x values would have been obtained from Equation (9), as follows:

bottom of column: $y/x = 1.10$
top of column: $y/x = 1.01$

The y/x value of 1.01, while not the correct value at the top of the column, is more nearly correct at that location than the value of 1.10 which would be calculated from Equation (3).

Effect of Gas Partial Pressure on Value of K: Ethane in Dimethoxytetraethylene-Glycol—A further example might serve to indicate the error involved in calculating a K value from gas solubility data and assuming the value of K to be constant so long as system temperature and total pressure remain constant. From data obtained in the Bureau of Industrial Chemistry,[5] it has been found that the Bunsen solubility coefficient for ethane in dimethoxytetraethyleneglycol (DMTG) is 2.16 to 40 F. Thus from Equation (15) the value of y/x, for pure ethane gas over DMTG at a total system pressure of 4 atmospheres, would be 12.97. However, it might be assumed that ethane in a gas mixture entering an absorber, operating at 40 F. and 4 atmospheres with DMTG solvent, is present only to an extent of 3.0 percent. From Equation (15) the y/x for ethane entering the absorber would be 12.00. Actually the y/x value would then be substantially constant throughout the tower. The significance of the calculations is the difference between the value of 12.00 and that of 12.97.

Effect of Gas Partial Pressure on Value of K: Methane in Decane—Still another example might serve to indicate the error to be anticipated in assuming for certain systems that K is a function solely of system temperature and system pressure. Data for the methane-decane system[7] is employed in this instance. Table 1 below shows a tabulation, over the pressure range from 20 psia to 1000 psia, of $\pi y/x$ and of $\pi y/X$, at 100 F. and 220 F.

At a system pressure of 100 atmospheres and a system temperature of 100 F., the y/x value for methane, using the above H′ values, would be 3.41 for a methane y value of 0.68 (methane partial pressure of 1000 psia). It would be 2.36 for a methane y value of 0.063 (methane partial pressure of 100 psia). In contrast a standard K factor chart would show a single value of K for these two conditions; the "deviation" of the methane K factor with concentration may thus be explained and evaluated mathematically. Hence it is shown that, for some systems, K is not a function solely of system temperature and pressure, and that for such systems a plot of p/X vs. p or log p should be employed instead of the various conventional K factor charts. Figure 1 employs the data of Table 1 to illustrate one method of plotting values of p/X.

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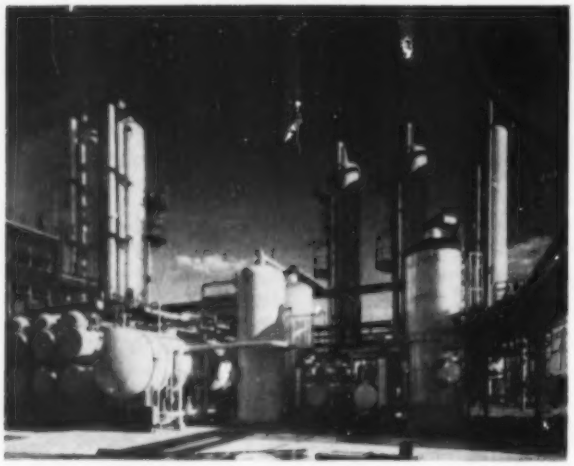
TABLE 1

	100 F		220 F	
Methane Partial Pressure, psia.	$\pi y = H_{100\ F.}$ / x	$\pi y = H'_{100\ F.}$ / X	$\pi y = H_{220\ F.}$ / x	$\pi y = H'_{220\ F.}$ / X
20	191.35	190.75	239.65	238.33
60	193.87	189.80	239.63	235.67
100	196.81	190.01	242.45	235.78
200	203.94	190.34	247.74	234.29
400	217.07	189.90	258.39	231.37
600	229.82	189.06	268.65	228.08
800	242.25	187.88	278.10	223.95
1000	253.42	185.49	287.62	219.93
Ratio, max./min.	1.324	1.032	1.200	1.083

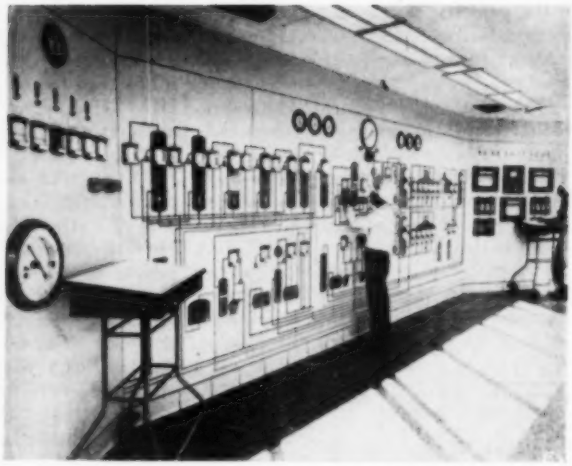
NOMENCLATURE

H — "constant," ratio atm. partial pressure of component in vapor to mole fraction of that component in solution.
H′ — "constant," ratio atm. partial pressure of component in vapor to mole ratio of that component in solution.
K — equilibrium value of y/x.
K′ — equilibrium value of y/X.
k′ — constant.
P — vapor pressure of gas component, in atm., at the system temperature.
p — partial pressure of component in vapor phase, atm.
V — gram molecular volume of gas component at 32 F. and 1 atm., cc.
v — volumes of gas component, measured at constant values of temperature and pressure, dissolved in unit volume of solvent.
W — molecular weight of solvent.
X — mole ratio of solute to solvent.
x — mole fraction of solute in solution.
y — mole fraction of gas component in vapor.
α — Bunsen gas solubility coefficient, volume of gas, measured at 32 F. and 1 atm., dissolved, at the temperature of the system, in 1 volume of solvent when the partial pressure of the gas is 1 atm.
γ — activity coefficient in equation: $\pi y = \gamma Px$.
γ' — activity coefficient in equation: $\pi y = \gamma' PX$.
π — total system pressure, atm. abs.
ρ — solvent density, g/cc.

Note: The expression y/x, is understood throughout to signify the equilibrium ratio.

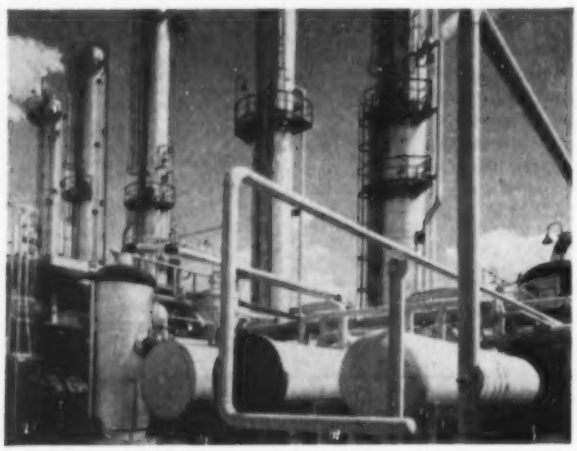


1. National Petro-Chemicals gas processing at Tuscola, Ill., starts with this extraction plant . . .

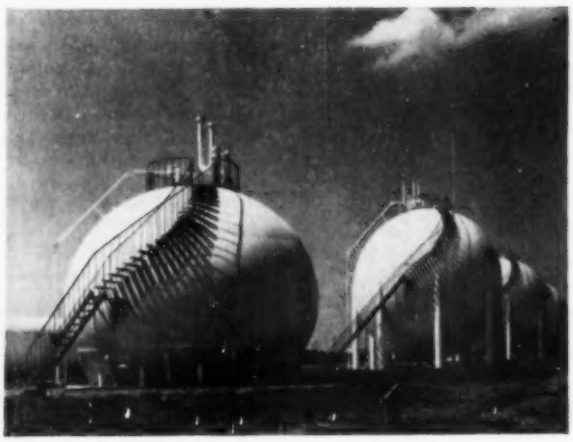


2. Nerve center for the extraction plant is this graphic panel . . .

Tour through National's . . .

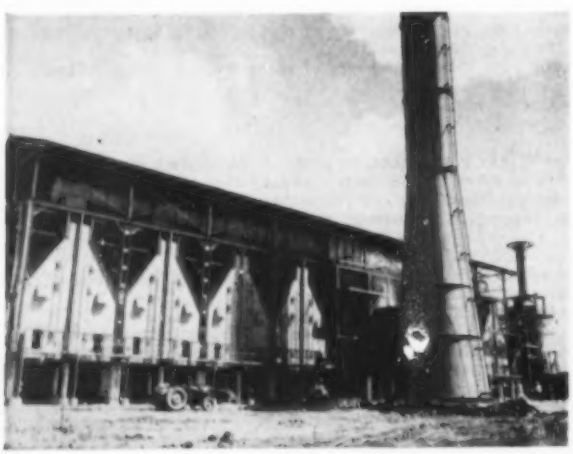


3. Fractionation plant yields ethane, propane, isobutane, normal butane and gasoline . . .

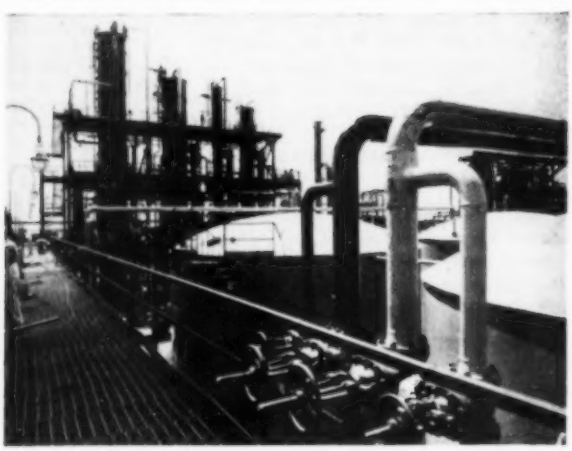


4. Tank farm including underground caverns can store nine million gallons of liquid hydrocarbons . . .

. . . Petrochemical Plant



5. Ethane cracking furnaces are first step in ethylene plant . . .



6. Synthetic alcohol unit can produce 125,000 gallons of 192 proof alcohol per day. Other plant products: ammonia and sulfuric acid.

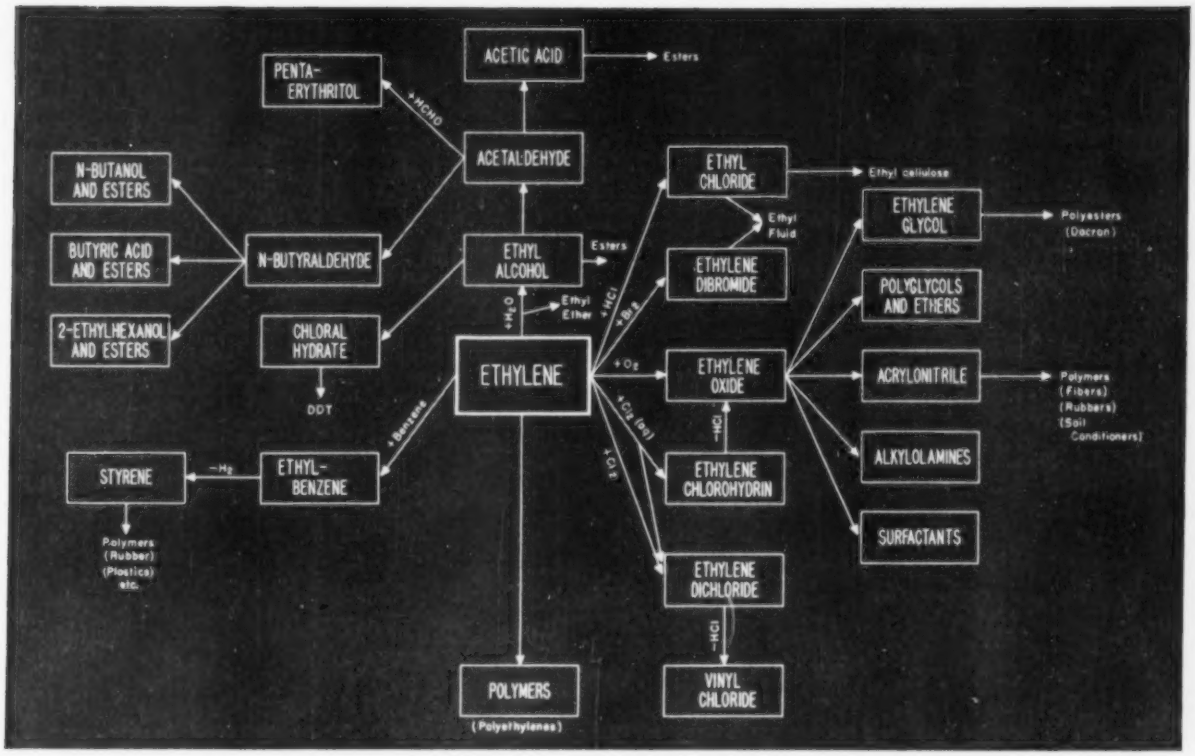


Figure 1. Chemical Derivatives of Ethylene (Courtesy of Dr. J. P. Cunningham, Shell Chemical Corporation)

Understanding the chemistry of . . .

Petrochemical Reactions

Part 6. Nitration and Sulfonation of Paraffin and Aromatic Hydrocarbons

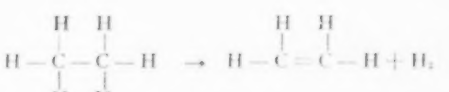
Part 7. The Reactions of the Olefins

Part 8. The Production of Olefins

Lewis F. Hatch, The University of Texas, Austin

THE EARLIER parts of this series on petrochemicals were primarily devoted to the paraffin hydrocarbons and aromatic hydrocarbons. The remainder of the series will pertain to the petrochemistry of unsaturated hydrocarbons: olefins, diolefins and acetylene. The paraffins are relatively stable while the olefins are much more reactive and amenable to a wide variety of reactions, most of which have petrochemical interest. Olefins are to petrochemicals what chlorophyll is advertised to be to the fastidious—indispensable!

What Is An Olefin? Olefins may be made by the removal of atoms or groups from adjoining carbons atoms in a saturated molecule, and this gives a clue as to their structure.



Ethane
A paraffin

Ethylene
An olefin

The structure of the resulting olefin, however, is not quite as simple as depicted by a double bond (=), because the newly-formed bond actually consists of an electron pair (*pi* electrons) which is more reactive than the electron pair (*sigma* electrons) originally forming the single bond between the carbon atoms. The two types of bonds are sometimes depicted in this manner:

$$CH_2 \overset{\sigma}{=} CH_2$$

This type of linkage between the carbon atoms accounts for the difference between paraffin hydrocarbons and olefins in respect to types of reaction. Olefins react by addition; paraffins, by substitution.

How Do Olefins React? The reactions of olefins are essentially those which one would expect if the double bond of the olefin is thought of as forming the following radicals.

$$R-CH-CH_2 \rightleftharpoons R-CH=CH_2 \rightleftharpoons R-CH-CH_2$$
$$\ddot{-} \quad + \qquad\qquad + \quad \ddot{-}$$

The relative amounts of each kind of radical will vary for different olefins and the conditions of the reaction. These radicals add other atoms or groups in a stepwise fashion to form stable derivatives which are saturated. This may be illustrated by the addition of hydrogen chloride to propylene.

$$CH_3-CH=CH_2 \rightarrow CH_3-\overset{+}{C}H-CH_2 + H^+Cl^- \rightarrow CH_3-CH-CH_3 + Cl^-$$
$$\ddot{-} \quad - \qquad\qquad +$$

A carbonium ion

$$CH_3-\overset{+}{C}H-CH_3 + Cl^- \rightarrow CH_3-\underset{Cl}{CH}-CH_3$$

The olefinic double bond is nucleophilic; this means that it will react first with the positive portion of the reactant to form a carbonium ion (positive ion). The remaining portion of that which is reacting will then add to this positive ion.

The ease with which the addition occurs varies with the nature of the olefin and of the material which is reacting. The order of reactivity olefins is ethylene< propylene<butylenes<isobutylene. The higher molecular weight olefins all have about the same reactivity. There is a distinct difference in reactivity between ethylene and propylene and between straight chain and tertiary olefins (i.e. isobutylene). The carbon-carbon double bond is under strain and the driving force of their reactions is in a large measure the release of this strain. The rate of reaction may often be greatly increased by the use of a suitable catalyst. Reactions which take place by addition usually do so more readily than those which replace an atom—substitution or displacement reactions.

With What Do Olefins React? The following reactions of olefins are not the only ones, but they are the most important from an industrial standpoint. In general, olefins react easily with such reagents as strong acids (H^+), halogens and oxidizing agents, but they will not react readily with ammonia, amines ($R\text{-}NH_2$) or hydrogen cyanide.

TABLE 1. Reactions of Olefins

Olefins	Hydrogenation	Paraffin hydrocarbons	
	Sulfation	Alcohols	
		Ethers	
		Alkyl sulfates	
	Halogenation	By addition	Olefin dihalides
		By substitution	Allylic halides
			Vinyl halides
	Hydrohalogenation	Alkyl halides	
	Hypohalogenation	Halohydrins	
	Oxidation	Oxides	
		Aldehydes and acids	
		Glycols	
	Polymerization	Alkylates	
		Polyolefins	
	Alkylation	Alkylates	
		Alkyl aromatics	
	Isomerization	Isomeric olefins	
	Oxo Reaction	Aldehydes	
		Alcohols	

Ethylene is the most important olefin industrially, because it is readily available at a low cost and its derivatives are useful (see Figure 1). However, it will not be used to illustrate the reactions of olefins, because it is not typical. Ethylene is symmetrical while most olefins (propylene, for example) are not. If the material adding is symmetrical, there is only one possible product regardless of the nature of the olefin; but, if the material adding is unsymmetrical, then two products are possible. This can be illustrated by the addition of hydrogen and hydrogen chloride to propylene.

$$CH_3CH=CH_2 + H_2 \rightarrow CH_3CH_2CH_3$$
$$CH_3CH=CH_2 + HCl \rightarrow CH_3CH_2CH_2Cl \text{ or } CH_3CHClCH_3$$

n-Propyl chloride Isopropyl chloride

Hydrogenation. The addition of hydrogen to an olefin to produce a paraffin hydrocarbon is an important reaction but not for the lower molecular weight olefins.

$$CH_3CH=CH_2 + H_2 \xrightarrow{\text{Catalyst}} CH_3CH_2CH_3$$

The reaction is primarily used to saturate olefin derivatives such as unsaturated fats which are hydrogenated to produce oleomargarine. Numerous catalysts including nickel, platinum, palladium and copper are used for hydrogenations.

Sulfation. Olefins will add sulfuric acid to form mono- and dialkyl sulfates.

$$CH_3CH=CH_2 + H_2SO_4 \rightarrow CH_3\underset{|}{CH}-O-SO_2-OH$$

Isopropyl hydrogen sulfate

$$CH_3CH=CH_2 + CH_3\underset{|}{CH}-O-SO_2-OH \rightarrow CH_3\underset{|}{CH}-O-SO_2-O-\underset{|}{CH}CH_3$$

Diisopropyl sulfate

These compounds are esters and are readily hydrolyzed to yield an alcohol and sulfuric acid. With the exception of ethylene, the alcohol always has the —OH group on the carbon atom containing the least number of hydrogen atoms.

$$CH_3\underset{|}{CH}-O-SO_2-OH + H_2O \rightarrow CH_3CHOHCH_3 + H_2SO_4$$

Isopropyl alcohol

The sulfation of olefins followed by hydrolysis to yield alcohols is probably the most important process in petrochemistry.

Reactions With Halogens. Olefins react with chlorine or bromine at low temperatures to product the olefin dihalides.

$$CH_3CH=CH_2 + Cl_2 \xrightarrow{25^\circ C.} CH_3CHClCH_2Cl$$

Propylene dichloride
(1,2-Dichloropropane)

Fluorine is too reactive and iodine not reactive enough to undergo this reaction.

When a temperature of 250 C. or higher is used, a substitution reaction predominates to give an allylic halide ($RCH=CHCH_2X$).

$$CH_3CH=CH_2 + Cl_2 \xrightarrow{500^\circ C.} CH_2=CHCH_2Cl + HCl$$

Allyl chloride
(3-Chloro-1-propene)

This reaction is the start of Shell's famed process for the production of glycerol from petroleum.

The same type of reaction will take place with isobutyl-

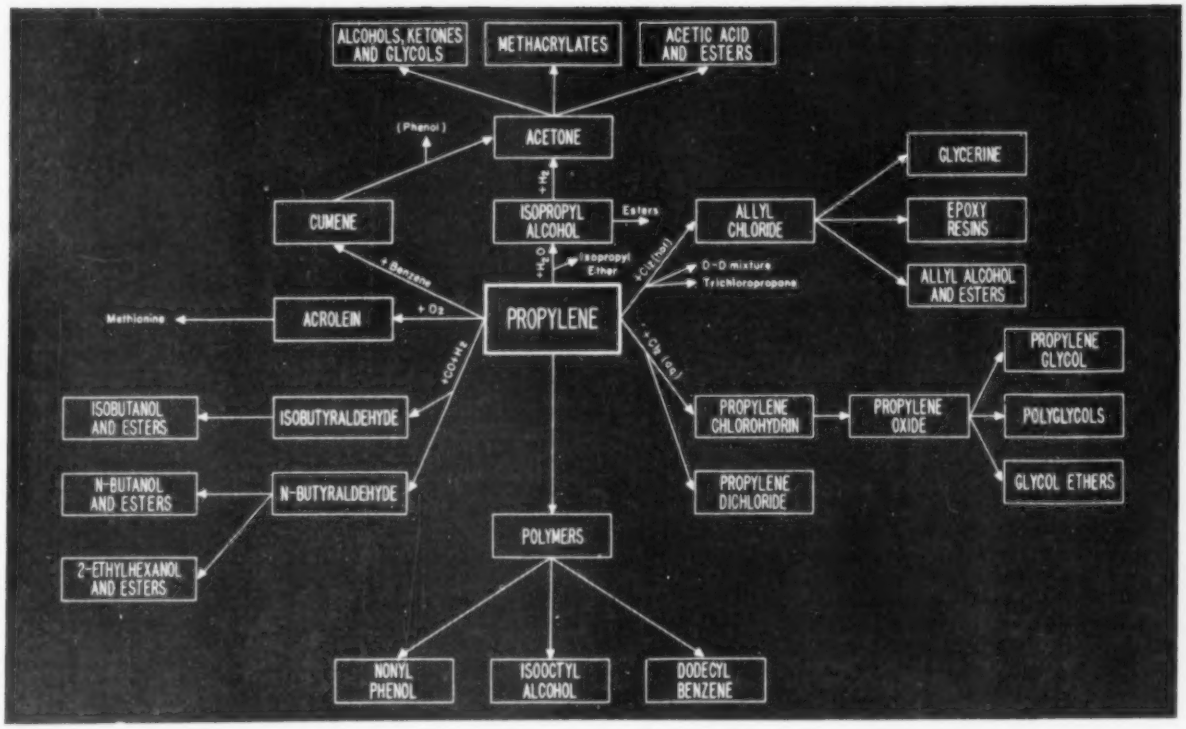


Figure 2. Chemical Derivatives of Propylene (Courtesy of Dr. J. P. Cunningham, Shell Chemical Corporation)

ene at low temperatures where straight chain olefins react by addition.

$$CH_3C=CH_2 + Cl_2 \rightarrow CH_2=CCH_2Cl + HCl$$

Methallyl chloride
(3-Chloro-2-methyl-1-propene)

Hydrohalogenation. The addition of hydrogen chloride to an olefin under fairly mild conditions to give isopropyl chloride had been previously noted. Other hydrogen halides will also react, with the order of reactivity being HI HBr HCl. The addition of HCl to ethylene requires a catalyst such as aluminum chloride.

The addition of hydrogen bromide to an olefin will give either of two products depending upon whether or not peroxides are present.

$$CH_3CH=CH_2 + HBr \xrightarrow[\text{absent}]{\text{Peroxides}} CH_3CHBrCH_3 \text{ "Normal product"}$$

$$CH_3CH=CH_2 + HBr \xrightarrow[\text{present}]{\text{Peroxides}} CH_3CH_2CH_2Br \text{ "Abnormal product"}$$

This is known as the "peroxide effect" and is a special situation which applies only to HBr and several miscellaneous chemicals such as mercaptans and bisulfite.

Hypohalogenation. Olefins will add hypochlorous acid at low temperatures to give chlorohydrins (RCHOHCHClR).

$$Cl_2 + H_2O \rightleftharpoons HOCl + HCl$$

$$CH_3CH=CH_2 + HOCl \rightarrow CH_3CHOHCH_2Cl$$

Propylene chlorohydrin

A small amount of the other possible product ($CH_3CHCl-CH_2OH$) is also formed. Hypobromous acids adds similarly to give bromohydrins. The chlorohydrins are used as intermediates in the production of glycols.

Oxidation. The oxidation of olefins may give a number of different products depending upon the conditions, oxidizing agent, catalyst, etc. Dichromate, permanganate and ozone oxidation, give carbonyl ($-\overset{O}{\overset{\|}{C}}-$) compounds.

$$CH_3CH=CH_2 \rightarrow CH_3\overset{O}{\overset{\|}{C}}-H + H-\overset{O}{\overset{\|}{C}}-H \rightarrow CH_3\overset{O}{\overset{\|}{C}}-OH + H-\overset{O}{\overset{\|}{C}}-OH$$

Acetaldehyde — Formaldehyde — Acetic acid — Formic acid

Cold dilute permanganate or hydrogen peroxide oxidation will give glycols (RCHOHCHOHR).

$$CH_3CH=CH_2 + (HO-OH) \rightarrow CH_3CHOHCH_2OH$$

Propylene glycol

The oxidation of an olefin in the presence of a silver or similar catalyst will give an oxide ($\overset{O}{\diagup\diagdown}$ (RCH—CHR)).

$$CH_3CH=CH_2 + O_2 \xrightarrow{\text{Catalyst}} CH_3\overset{O}{\overset{/\diagdown}{CH}}-CH_2$$

Propylene oxide

A special case of oxidation is that of propylene to acrolein.

$$CH_3CH=CH_2 + O_2 \rightarrow CH_2=CH-\overset{O}{\overset{\|}{C}}-H$$

Acrolein

The main use of oxides is in the production of glycols. A good use for acrolein is still to be found.

Polymerization. The polymerization of olefins usually

has as its objective either the formation of dimers or similar low molecular weight products (alkylation) or high molecular weight plastics. In the latter class is polyethylene which is predicted to become our first billion pound plastic. In either case the reaction is one of addition.

$$nCH_2=CH_2 \xrightarrow[\text{Pressure}\ \text{Heat}]{\text{Catalyst}} (-CH_2CH_2-)n$$

Polyethylene

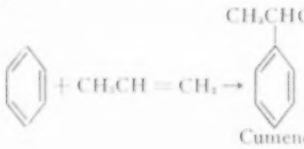
A typical dimerization or alkylation is that of isobutylene and isobutane.

$$CH_3C(CH_3)=CH_2 + CH_3CH(CH_3)CH_3 \xrightarrow[(HF)]{(H_2SO_4)} CH_3C(CH_3)_2-CH_2-CH(CH_3)_2$$

"Isooctane"

Other olefins may also be used.

Alkylation. The alkylation of aromatic compounds is a very important means of providing raw material for the production of such widely divergent materials as styrene, phenol, acetone, artificial musk and alkylaryl sulfonates (synthetic detergents). The term alkylation (Friedel-Crafts reaction) is a broad one and includes the use of alcohols and alkyl halides as well as olefins. It also includes a wide variety of catalysts of which aluminum chloride is the best known.



Cumene

Only ethylene will give a straight chain alkyl group on the benzene ring.

The term alkylation is also used for the dimerization of two olefins or the reaction between an olefin and a paraffin hydrocarbon (isobutane).

Isomerization. Olefins may be isomerized in respect to the position of their double bonds.

$$CH_3CH_2CH=CH_2 \xrightarrow[650°\ C.]{\text{Catalyst}} CH_3CH=CHCH_3$$

1-Butene 2-Butene

There may also be a carbon chain isomerization similar to that which is characteristic of the $HCl/AlCl_3$ isomerization of paraffins.

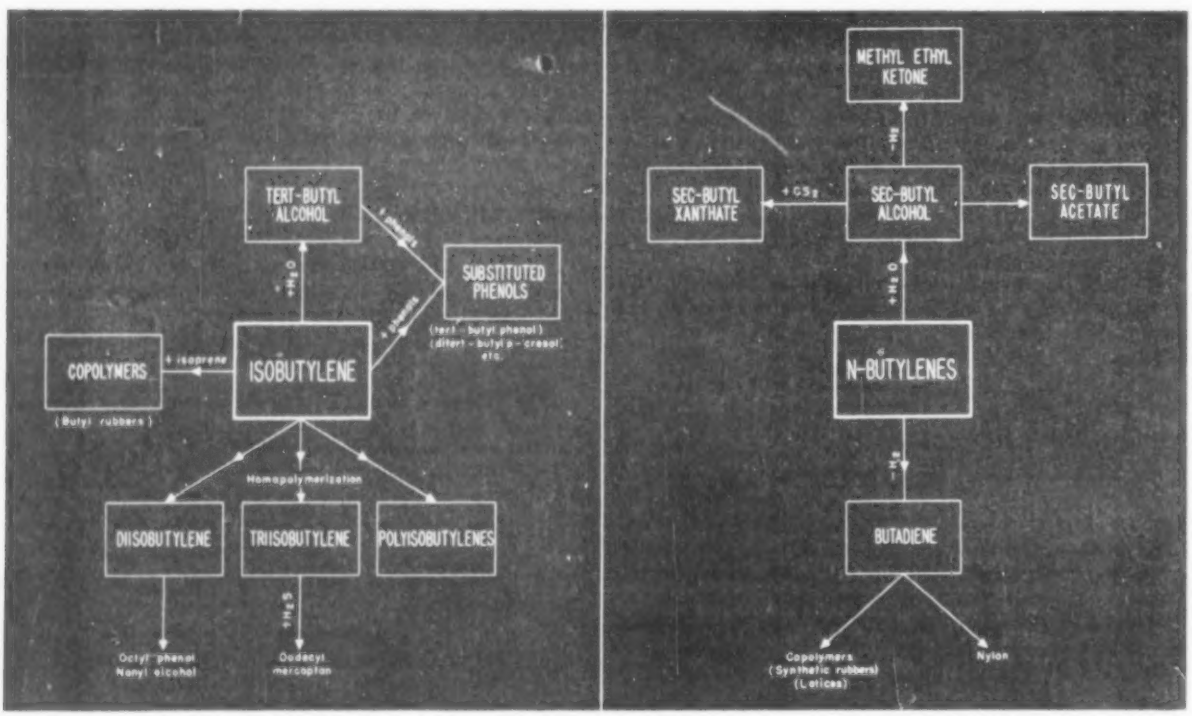
Oxo Reaction. The oxo reaction is similar to the Fischer-Tropsch process in that they both use carbon monoxide and hydrogen. In the oxo process the reaction is between these two reagents and an olefin to product an aldehyde (and a small amount of ketone).

$$CH_3CH=CH_2 + CO + H_2 \rightarrow CH_3CH(CH_3)C(=O)-H + CH_3CH_2CH_2C(=O)-H$$

α-Methylpropionaldehyde Butyraldehyde

This reaction requires a high pressure (2000 psi) and temperature (130 C.) and a catalyst (CoO, ThO_2, MgO). The aldehydes are hydrogenated to the corresponding primary alcohols.

End of Part 7. Part 8 will appear in an early issue.



ISOBUTYLENE **N-BUTYLENES**

Figure 3. Chemical Derivatives of Butylenes (Courtesy of Dr. J. P. Cunningham, Shell Chemical Corporation).

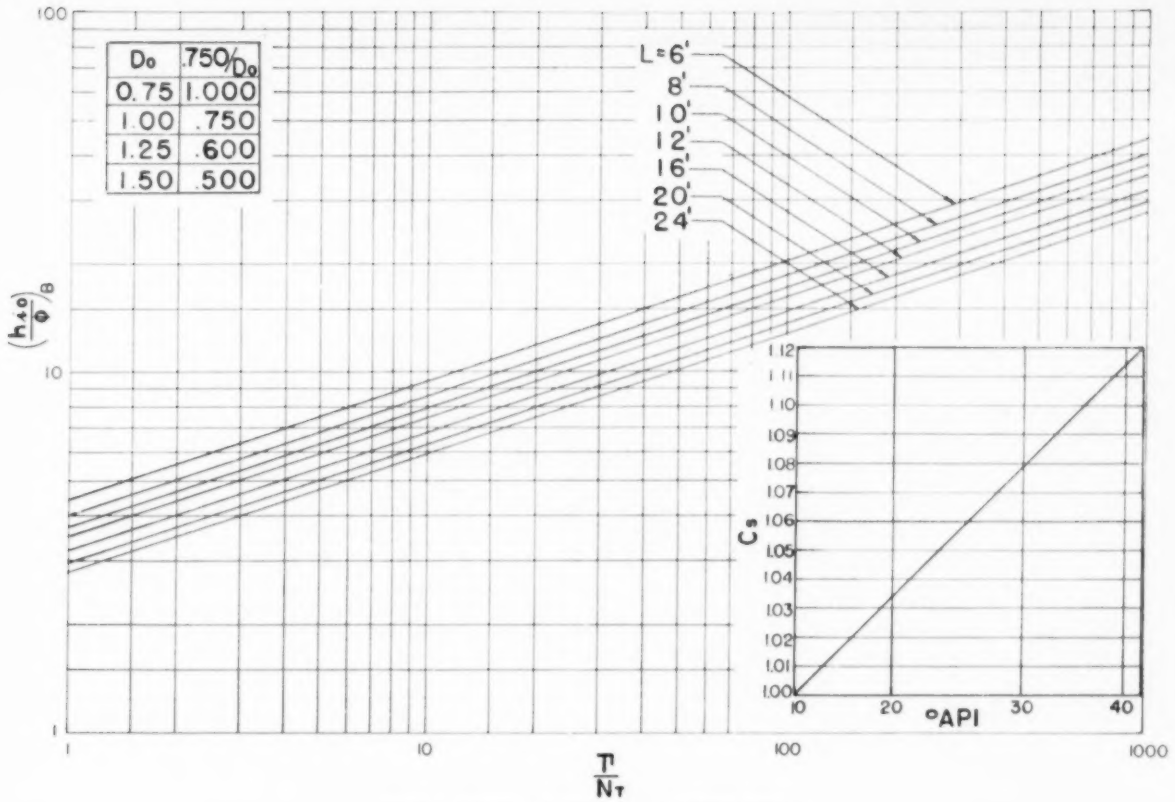


Figure 1. Viscous flow film coefficients inside tubes.

$$\left[\text{Not to be extrapolated beyond } \frac{T'}{N_T} = 40\,Di\left(\frac{Z}{S}\right)\right]$$

Simplified Design for . . .

Viscous Oil Heat Exchangers

Methods and examples are given for viscous flow for three broad categories:

- **Flow inside tubes**
- **Unbaffled flow outside a bare tube bundle**
- **Outside a longitudinally finned tube bundle**

Abe Devore and Joseph E. Heinz, Davis Engineering Corporation, Elizabeth, N.J.

THE HEAT TRANSFER calculations in the viscous region are always complicated by trial-and-error solutions. In this paper rapid methods are presented which simplify these heretofore complicated calculations. The design procedure developed here is concerned primarily with hydrocarbon oils; however, the extension of the equations and curves to other viscous fluids is indicated.

The process conditions will usually determine the type of exchanger to employ. For example, a highly fouling oil is best routed through the tubes. If the operating pressure is very high, optimum design again usually favors routing the oil through the tubes.

Where pressure drop is restricted to low values, unbaffled flow outside either a bare or a longitudinally finned tube bundle is advantageous.

In the illustrative problem given in this paper, a comparison will be made between the three alternative designs.

Development of the Design Equations

A. Flow Inside Tubes

(i) *Heat Transfer*

The familiar Sieder-Tate[2] equation is:

$$N_{No} = 1.86\left[N_{Re}\,N_{Pr}\left(\frac{D_i'}{L}\right)\right]^{\frac{1}{3}}\phi \qquad (1\text{-A})$$

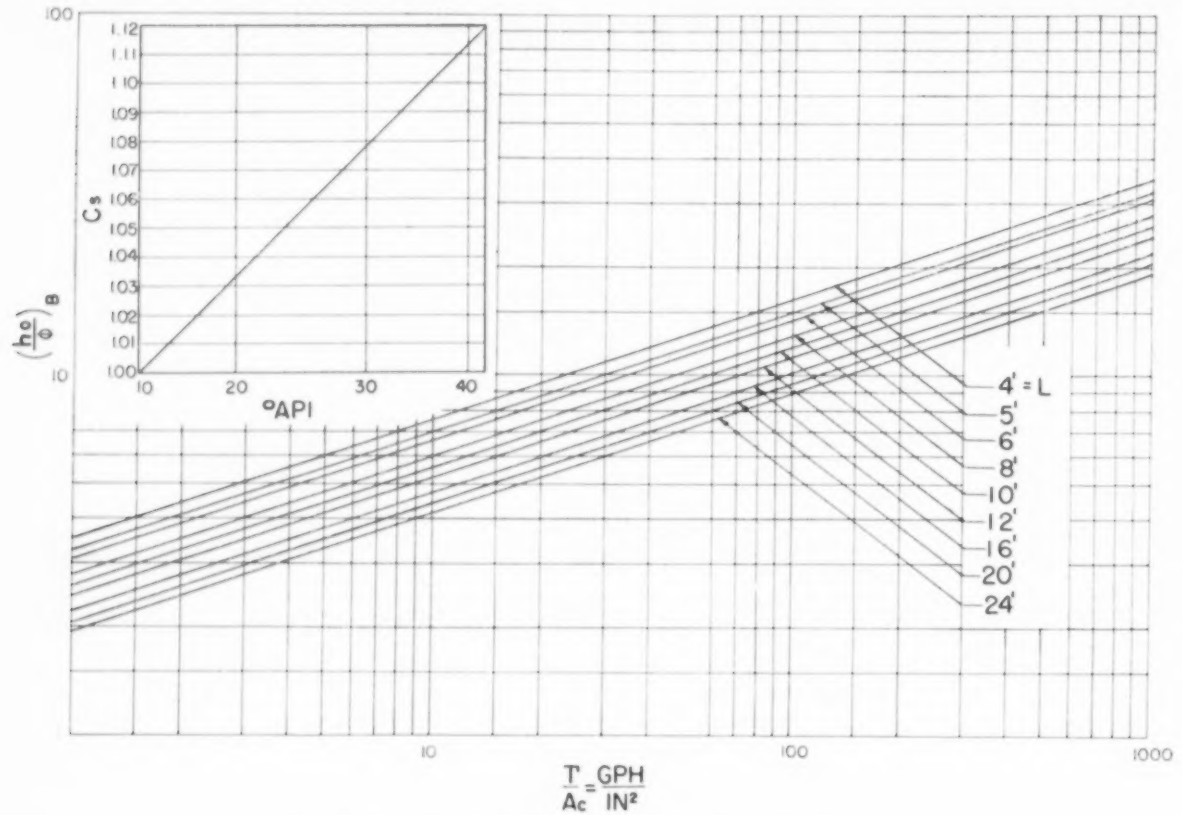


Figure 2. Viscous flow film coefficients unbaffled flow outside tube bundle.

$\left[\text{Not to be extrapolated beyond } \frac{\Gamma}{A_c} = 50\,\frac{(Z/S)}{D_o}\right]$

Introducing D_i, G and Z, and solving for h_i/ϕ

$$\frac{h_i}{\phi} = 65.3\,(k^2c)^{1/3}\left[\frac{G}{D_iL}\right]^{1/3} \qquad (2\text{-A})$$

G can be expressed in terms of Γ, S, N_T and D_i as

$$G = \frac{0.425S}{D_i^2}\left(\frac{\Gamma}{N_T}\right) \qquad (3\text{-A})$$

Remembering that $h_{io} = \frac{h_i D_i}{D_o}$, we can rewrite equation (2-A) as

$$\frac{h_{io}}{\phi} = \frac{49.0}{D_o}\left[\frac{\Gamma}{N_TL}\right]^{1/3}(k^2cS)^{1/3} \qquad (4\text{-A})$$

Equation (4-A) expresses h_{io} explicitly in terms of all the independent design variables. In addition to the well-known cube-root function of velocity and length, (4-A) points up a rather peculiar fact; to wit, h_{io} is *independent* of the inside tube diameter, D_i. Furthermore, $h_{io}D_o$ is constant i.e.; $-h_{io}$ varies inversely with D_o.

The viscosity term, Z, does not appear as such in equation (4-A). h_{io} is proportional to $\phi = (Z/Z_w)^{0.14}$. The magnitude of ϕ is determined by the slope of the viscosity-temperature curve for the given oil. Oils of low viscosity-index (i.e., steep viscosity-temperature slope) will yield higher values of h_{io} than high viscosity-index oils (i.e., oils of high viscosity-temperature stability) under a given set of process temperature conditions.

The term $(k^2cS)^{1/3}$ is practically constant[3] over wide temperature ranges for hydrocarbon oils of a given gravity. It follows, then, that h_{io}/ϕ is independent of temperature for a given °API oil.

The value of $(k^2cS)^{1/3}$ is 0.1230 for a 10° API oil (Table 4).

Selecting 10° API oil and D_o = 0.750 as *reference*—values, equation (4-A) becomes

$$\frac{h_{io}}{\phi} = 8.04\left[\frac{\Gamma}{N_TL}\right]^{1/3} \qquad (5\text{-A})$$

Figure 1 is a plot of this equation.

Inspection of equation (4-A) indicates that we can rewrite (5-A) for any combination of oil gravity and outside tube diameter as

$$\frac{h_{io}}{\phi} = \frac{(k^2cS)^{1/3}}{0.1230}\left(\frac{0.750}{D_o}\right)\left(\frac{h_{io}}{\phi}\right)_B = C_S\left(\frac{.750}{D_o}\right)\left(\frac{h_{io}}{\phi}\right)_B \qquad (6\text{-A})$$

The factor C_S is plotted against an arbitrary scale for gravity and $(.750/D_o)$ is tabulated on Figure 1.

With high viscosity oils, natural convection effects are of no importance; therefore, no correction of h_{io} is necessary.

The limitations of equation (6-A) are expressed alternatively as

$$N_{Re} \leqslant 2100$$
$$\text{or } (\Gamma/N_T) \leqslant 40\,D_i\,(Z/S)$$

(ii) *Pressure Drop*

Introducing V, Z and D_i, the familiar Hagen-Poiseuille[4] equation assumes the form

$$\Delta P_F = \frac{6.69 \times 10^{-4}\,VLZ}{D_i^2} \qquad (7\text{-A})$$

To correct for the effect of heating and cooling, McAdams[1] recommends the Sieder-Tate correction, $1.1\,(Z/Z_w)^{0.23}$.

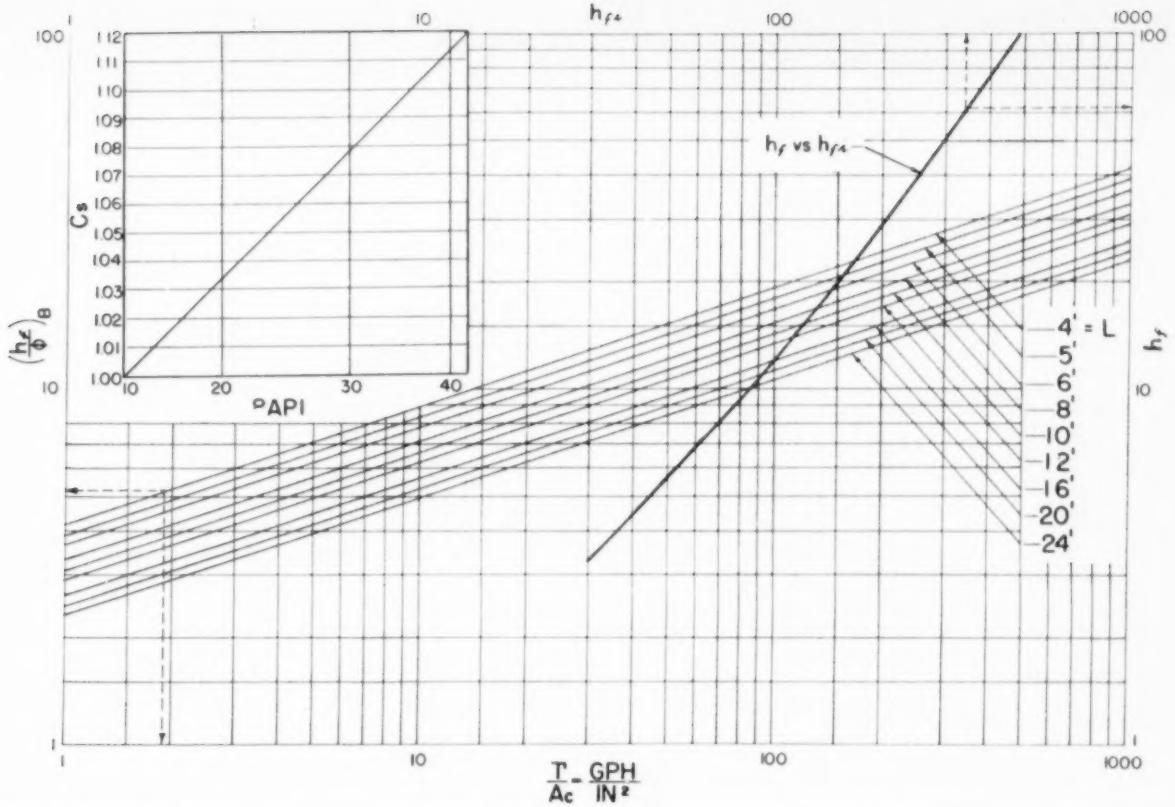


Figure 3. Viscous flow finside film coefficients and weighted efficiency curve. Tube specifications:—1-inch od #12 BWG steel tube with 20½-inch high 320 BWG (.035-inch) thick longitudinal steel fins per tube.

$$\left[\text{Not to be extrapolated beyond } \frac{\Gamma}{A_c} = 5\,\frac{(Z/S)}{D_c}\right]$$

$$\Delta P_T = \frac{6.08 \times 10^{-4}\, VLZ}{D_i^{\,2}\phi} \qquad (8\text{-A})$$

Because of its extreme simplicity, this equation rather than the generalized Fanning factor, is preferable. It has the important advantage of underscoring the influence of the controlling variables. If pressure drop presents any difficulty, it is evident from equation (8-A) that larger tube diameters will reduce this loss as a square-function.

The velocity, V, is evaluated from Γ/N_T as

$$V = \frac{\Gamma/N_T}{147\, D_i^{\,2}} \qquad (9\text{-A})$$

B. Unbaffled Flow Outside a Tube Bundle

(i) *Heat Transfer*

In a paper[5] dealing with flow in annular spaces, Carpenter et al correlate their data in the viscous flow region with the alternate form of the Sieder-Tate equation as

$$\frac{h_o D_e'}{k} = 1.86\left[\frac{4wc}{\pi kL}\right]^{1/3}\phi \qquad (1\text{-B})$$

For annuli (of double pipe exchangers), the experimental evidence indicates that (1-A) cannot be rewritten with D_e' substituted indiscriminately for D_i'.

Without proof, Kern[6] suggests that D_e' be substituted for D_i' in unbaffled shell and tube exchangers. If we accept equation (1-B) as the basic relationship, it may be shown that this idea is a sound one. A proof is offered below.

In computing D_e' for an unbaffled exchanger, the wetted shell perimeter is negligible in comparison with that for the tubes. Thus

$$D_e' = \frac{4A_c'}{T_S \pi D_o'} \qquad (2\text{-B})$$

The cross-sectional area of a hypothetical tube of diameter D_e' is

$$a' = \frac{\pi}{4} D_e'^{\,2}$$

$$= \frac{4}{\pi}\left[\frac{A_c'}{T_S D_o'}\right]^2 \qquad (3\text{-B})$$

The number of hypothetical tubes comprising A_c' is

$$T_S' = \frac{(T_S D_o')^2}{A_c'}\,\frac{\pi}{4} \qquad (4\text{-B})$$

Also,

$$w = \frac{W}{T_S'}$$

$$= \frac{4WA_c'}{\pi (T_S D_o')^2} \qquad (5\text{-B})$$

Combining (1-B), (3-B), (4-B), and (5-B) yields

$$\frac{h_o D_e'}{k} = 1.86\left[\left(\frac{D_e' G}{\mu}\right)\left(\frac{c\mu}{k}\right)\left(\frac{D_e'}{L}\right)\right]^{1/3}\phi \qquad (6\text{-B})$$

Equation (6-B) is precisely equation (1-A) with D_e' substituted for D_i'.

It follows from equation (6-B) that we can rewrite equation (2-A) for unbaffled flow as

$$\frac{h_o}{\phi} = 65.3\,(k^2c)^{1/3}\left[\frac{G}{D_e L}\right]^{1/3} \qquad (7\text{-B})$$

Introducing Γ, S and A_c,

$$\frac{h_o}{\phi} = \frac{45.25\,(k^2cS)^{1/3}\,(\Gamma/A_c)^{1/3}}{(LD_e)^{1/3}} \qquad (8\text{-B})$$

Again considering 10° API oil as a reference gravity and selecting D_e = 1.00 inch.

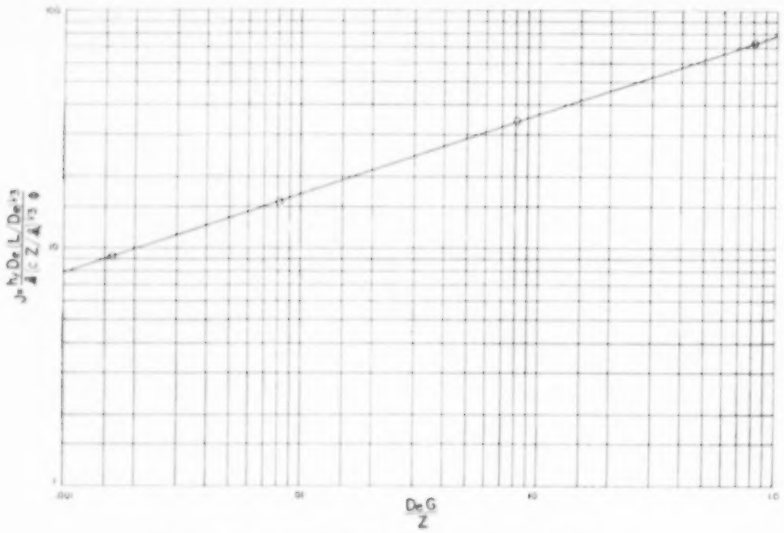


Figure 4. Heat transfer factor for viscous flow on inside.

$$\left(\frac{h_o}{\phi}\right)_B = \frac{5.57}{L^{1/3}}\,(\Gamma/Ac)_e^{1/3} \qquad (9\text{-B})$$

Figure 2 is a plot of equation (9-B).

The analogue of equation (6-A) for unbaffled flow is

$$\frac{h_o}{\phi} = \frac{Cs}{D_e^{1/3}}\left(\frac{h_o}{\phi}\right)_B \qquad (10\text{-B})$$

Equation (10-B) is valid for

$$N_{Re} \leqslant 2100$$

$$\text{or, } (\Gamma/Ac) \leqslant \frac{50\,(Z/S)}{D_e}$$

(ii) *Pressure Drop*

Jakob[6] recommends the substitution of D_e for D_i in this case.

Thus, equation (8-A) becomes

$$\Delta P_F = \frac{6.08 \times 10^{-4}\,VLZ}{D_e^2\phi} \qquad (11\text{-B})$$

The velocity, V, is evaluated as

$$V = \frac{(\Gamma/Ac)}{187} \qquad (12\text{-B})$$

C. Flow Outside a Longitudinally Finned Tube Bundle

(i) *Heat Transfer*

TABLE 1

DeLorenzo & Anderson Data for Double Pipe Exchangers

Outer Pipe: 3 Inch IPS Steel
Inner Pipe: 1¼ Inch IPS Steel
½ Inch High x .035 Inch th. Steel Fins

No. of Fins/Tube	L/De	$(L/De)^{1/3}$
36	65.9	4.03
28	53.6	3.77
24	47.9	3.66

DeLorenzo & Anderson,[7] experimenting with a double pipe exchanger, correlated their data (for longitudinal fins of constant thickness) with the Colburn heat-transfer factor

$$j = (N_{St})\,(N_{Pr})^{2/3}\phi^{-1} \qquad (1\text{-C})$$

The argument employed in part B justifies the extension of this correlation to shell and tube work.

Within the range of L/D_e values experimented with, the usual cube-root effect correlates the data very well. Theoretically,[4] and experimentally[2, 5, 7] we are justified in assuming an equation of the form.

$$h_f = \frac{k\,(CZ/K)^{1/3}\phi}{D_e\,(L/D_e)^{1/3}} \qquad (2\text{-C})$$

For any given L/D_e ratio, equations (1-C) and (2-C) must yield the same result.

Equating these expressions for h_f and solving for J

$$J = 16.1\,j\,(N_{Re})\,(L/D_e)^{1/3} \qquad (3\text{-C})$$

Tables 1, 2 and 3 give the calculated J values.

These are correlated in Figure 4 and represented analytically by

$$\left.\begin{aligned} J &= 78.0\left[\frac{D_e G}{Z}\right]^{1/3} \\ &= \frac{h_f\,D_e\,(L/D_e)^{1/3}}{k\,(CZ/k)^{1/3}} \end{aligned}\right\} \qquad (4\text{-C})$$

The equations (4-C) are a generalization of the DeLorenzo & Anderson correlation. While these latter authors' representation of their data is eminently suited for the standardized double pipe exchangers, equations (4-C) enable us to extend the results to the wider range of L/D_e values encountered in shell and tube work.

The analogue of (8-B) for this case is then

$$\frac{h_f}{\phi} = \frac{54.1}{(L/D_e)^{1/3}}\,(k^2cS)^{1/3}\,(\Gamma/Ac)^{1/3} \qquad (5\text{-C})$$

Again employing 10° API and $D_e = 1.00$ as reference values, we write

$$\left(\frac{h_f}{\phi}\right)_B = \frac{6.65}{L^{1/3}}\,(\Gamma/Ac)^{1/3} \qquad (6\text{-C})$$

and

$$\frac{h_f}{\phi} = \frac{Cs}{D_e^{1/3}}\left(\frac{h_f}{\phi}\right)_B \qquad (7\text{-C})$$

Figure 3 is a plot of equation (6-C).

The experimental data indicate that transitional flow occurs at $(N_{Re}) > 200$. This limits the range of equation (6-C) to

$$\Gamma/Ac \leqslant \frac{5\,(Z/S)}{D_e}$$

The evaluation of ϕ in equations (6-C) and (7-C) presents a difficulty not encountered in bare tube work. The core of this problem is the determination of t_w. Recognizing this fact, DeLorenzo & Anderson used an ingenious mathematical device to circumvent the complexity of a rigorous treatment. Their method is based on weighted fin efficiency, η'. In the derivation, the relatively negligible temperature drop across the metal wall (exclusive of the fins) is neglected, i.e., $t_w = T_w$.

Their equation is

$$t_w = \frac{\eta' h_f\,(T - t)}{h_i + h_f\,\eta'\,\dfrac{A}{A_i}} + t \qquad (8\text{-C})$$

Rearranging,

TABLE 2

N_{Re}	$D_eG\ Z = N_{Re} \cdot 124$	No. of Fins Tube	j	$J = 16.1\,j\,(N_{Re})\,(L/D_e)^{1/3}$
1	.00806	36	.240	15.57
		28	.260	15.77
		24	.273	15.91
10	.0806	36	.052	33.7
		28	.056	33.95
		24	.059	34.4
100	.806	36	.0112	72.7
		28	.0120	72.8
		24	.0127	73.8
200	1.611	36	.0071	92.2
		28	.0076	92.3
		24	.0080	93.1

TABLE 3

For each N_{Re}, the arithmetic mean of the J-values is computed

N_{Re}	$D_eG\ Z$	Average J
1	.00806	15.75
10	.0806	34.0
100	.806	73.1
200	1.611*	92.5*

* A J-value of 9.25 should correspond to $\frac{D_eG}{Z} = .001611$, because the slope of Figure 4 is ⅓.

$$t_w - t = \Delta t = \frac{\eta' h_i \Delta t_w}{h_i + h_{fi}}$$

$$= \frac{\left(\frac{A_i}{A}\right)\left(\frac{h_{fi}}{h_f}\right)\left(\frac{1}{h_{fi}}\right)\Delta t_w}{1/U_i} \qquad (9\text{-C})$$

Introducing a coefficient based on the total finside surface,

$$U = U_i \frac{A_i}{A}$$

equation (9-C) simplifies to

$$\Delta t = \frac{U}{h_f} \Delta t_w \qquad (10\text{-C})$$

(ii) *Pressure Drop*

The equations are analogous to those of the preceding section; however, DeLorenzo & Anderson obtained better correlation by omitting the coefficient 1.1 from the Sieder-Tate correction factor.

The analogue of equation (11-B) is then given by

$$\Delta P_f = \frac{6.69 \times 10^{-4} V L Z}{D_e^2 \phi} \qquad (11\text{-C})$$

Equation (12-B) converts Γ/Ac to velocity, V, for this case also.

In shell and tube work, a wide flexibility of design is indicated by equation (11-C). By varying the tube-pitch in a given size shell, D_e can be adjusted to the pressure drop requirement.

A comparison of equations (7-C) and (11-C) reveals that as tube-pitch is increased, ΔP_f will decrease faster than h_f. There seems little point, therefore, in using more than one definite size fintube for shell and tube exchangers. Figure 3 includes a plot of h_f versus h_{fi} (weighed efficiency curve) for a 1-inch od #12 BWG steel tube with 20½ inches high x .035 inch thick, steel fins (Table 5).

TABLE 4

The values of $(k^2 cS)^{1/3}$ listed below, were computed at 100, 200 and 300 F. Regardless of oil characterization factor, these do not vary by more than 2 percent from any one tabulated figure.

°API @ 60 F.	$(k^2 cS)^{1/3}$	C_s
10	.1230	1.000
20	.1271	1.033
30	.1328	1.079
40	.1370	1.114

TABLE 5

Calculation of Weighted Efficiency Curve for 1-Inch OD #12 BWG Steel Tube With 20½ Inches High x .035 Inch tk. Steel Fins

h_f	η	η'	$h_{fi} = h_f \eta' A_f/A_i$
1	0.985	0.986	9.30
4	0.942	0.948	35.7
9	0.883	0.895	75.9
16	0.810	0.830	125.0
25	0.739	0.766	180.5
36	0.668	0.703	238.0
49	0.605	0.646	298
64	0.548	0.596	360
81	0.498	0.551	421
100	0.455	0.512	483

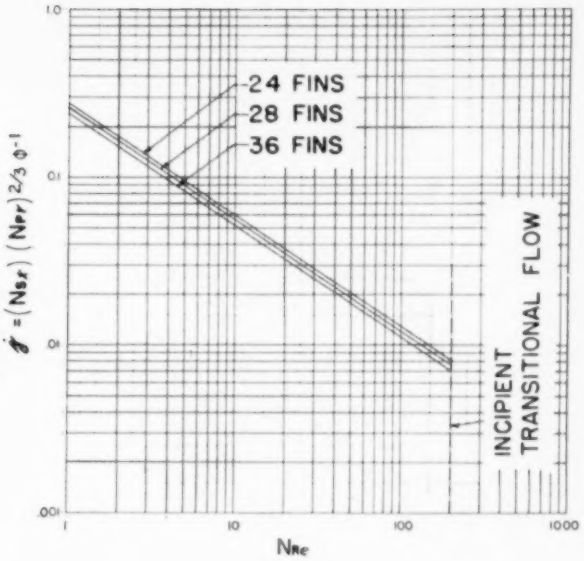


Figure 5. Heat transfer on finside of double pipe exchangers — heating and cooling. Fintube —1½ inch ips with ½-inch high x .035-inch thick fins in 3-inch ips shell.

Illustrative Problems

The application of the developed equations is illustrated in the solution of the following problems. The three types of exchangers discussed are used to satisfy a single set of process conditions. This procedure will allow a comparison between the three designs under equivalent circumstances.

It is assumed necessary to heat 6000 GPH of lube oil from 60 F. to 120 F. with process steam at atmospheric pressure. The physical properties are taken from Nelson[5] for SAE 30, 0.V.I., 21° API lube oil. As the heater is to be installed on the suction side of the pump, pressure drop is to be minimized.

A. Flow Inside Tubes (Unit 1)

Exchanger construction details: Welded integral tube sheet design; shell—20-inch steel pipe x .375-inch wall thickness; tubes—305—¾-inch OD x #16 BWG x 12 feet long steel on 15/16-inch triangular pitch; bundle entrance area equivalent to a 4-inch steam nozzle; total heat transfer surface 718 square feet.

(i) *Heat Transfer*

$$\frac{\Gamma}{N_T} = \frac{6000}{305} = 19.7; \quad 40\, D_i \frac{Z}{S} = 4250;$$

Figure 1 is applicable

$$\left[\frac{h_{io}}{\phi}\right]_B = 9.4; \quad C_s = 1.035$$

(Figure 1)

$$\Delta t = 120\ \text{F. (assumed)};$$
$$t_w = t + \Delta t = 240$$

$$\phi = \left[\frac{150}{8.8}\right]^{0.14} = 1.486$$

$$h_{io} = 9.4 \times 1.035 \times 1.486 = 14.45 \qquad (6\text{-A})$$

The condensate film resistance is negligible relative to the oil film resistance and is assumed to be 1/2000. The tube wall resistance is calculated as 1/4400.

$$U = \frac{1}{1/14.45 + 1/4400 + 1/2000} = 14.3$$

$$\Delta t = \frac{U}{h_{io}} \Delta t_w = 121\ \text{F.};$$
checks assumed value

Applying fouling factors of 1000 to the oil and 2000 to the steam

$$U\ \text{design} = 14$$

$$A = \frac{Q}{U \Delta t_m} = \frac{1{,}197{,}000}{14 \times 119.5} = 716\ \text{ft.}^2$$

(ii) *Pressure Loss*

$$V = 0.315\ \text{fps} \qquad (9\text{-A})$$

$$\Delta P_f = \frac{6.08 \times 10^{-4} \times .315 \times 12 \times 150}{(.652)^2 (2.03)}$$

$$= 0.399\ \text{psi} \qquad (8\text{-A})$$

B. Unbaffled Flow Outside A Tube Bundle (Unit 2)

Exchanger construction details: Two pass U-tube design; shell—20-inch steel pipe x .375-inch wall thickness; steel x 24 feet nominal developed length on 15/16-inch triangular pitch; total heat transfer surface 720 feet.[2]

(i) *Heat Transfer*

$$A_e = 146\ \text{in.}^2$$

$$D_e = 0.76\ \text{in.} \qquad (2\text{-B})$$

$$\frac{F}{A_c} = 41;\ 50\,\frac{(Z/S)}{D_e} = 10{,}700;$$

Figure 2 is applicable.

$$\left[\frac{h_{to}}{\phi}\right]_B = 8.4;\ C_s = 1.035;\ D_e^{1/3} = 0.9$$

(Figure 2)

$\Delta t = 120$ F. (assumed);
$t_w = t + \Delta t = 210$ F.
$\phi = 1.486$

$$h_{to} = \frac{8.4}{0.9} \times 1.035 \times 1.486 = 14.35 \quad (10\text{-B})$$

Steam film 2000; tube wall 4400
$U = 14.25$; $\Delta t = 121$ F.;
checks assumed value

Using the same fouling factors of 1000 and 2000 the design U is calculated to be 13.9. In this case 720 feet^2 are required.

(ii) *Pressure Loss*

$$V = 0.219 \text{ fps} \qquad (12\text{-B})$$

$$\Delta P_t = \frac{6.08 \times 10^{-4} \times .219 \times 12 \times 150}{(.76)^2\,(2.03)}$$

$= 0.204$ psi

(11-B)

C. Flow Outside a Longitudinally Finned Tube Bundle (Unit 3)

Exchanger construction details: Two pass U-tube design; shell—18-inch steel pipe x .312-inch wall thickness; tubes—38—1-inch od #12 BWG steel x 13 feet over-all length—12 feet finned with 20½-inch high x #20 BWG steel fins/tubes. Tube pitch 2¼ inches triangular. Dimensional characteristics of this tube are given in Table 6. Total finned heat transfer surface 875 feet.^{2}

(i) *Heat Transfer*

$D_e = 0.875$ in.^{2} (2-B)
$A_c = 192$ in.^{2}

$$\frac{F}{A_c} = 31.2;\ 5\,\frac{(Z/S)}{D_e} = 930;$$

Figure 3 is applicable.

$$\left[\frac{h_t}{\phi}\right]_B = 9.2;\ C_s = 1.035;\ D_e^{1/3} = 0.95$$

(Figure 3)

$\Delta t = 98$ F. (assumed);
$t_w = t + \Delta t = 188$ F.

$$\phi = \left[\frac{150}{10.2}\right]^{.14} = 1.456$$

$$h_t = \frac{9.2}{.95} \times 1.035 \times 1.456 = 14.6 \quad (7\text{-C})$$

$h_{ti} = 117$

(Figure 3)

TABLE 6
Design Constants for Standard Fintube

Cross-section area, in.^{2} = 1.182
Perimeter = outside surface/ft.
= 1.927 ft.
= 2312 in.
A/A_i = 9.42

NOMENCLATURE

Symbol		Quantity	Unit
		a. Simple Latin Letter Symbols	
A		Total outside heating surface	ft.^{2}
A_o		Outside heating surface of bare portion of longitudinal fintube	ft.^{2}
A_c	A_c'	Free flow area	in.^{2} ft.^{2}
A_f		Heating surface of fins	ft.^{2}
A_i		Inside heating surface of fintube	ft.^{2}
a		Cross-section area of a fin (across the width)	ft.^{2}
a'		Cross-section area of a hypothetical tube	ft.^{2}
B (subscript)		Denotes reference value	
C_s		Correction factor for oil gravity $(k^2/S)^{1/3}/0.1230$ for any viscous fluid	
c		Specific Heat	Btu/#-F.
D_i	D_i'	Inside tube diameter	in. ft.
D_e	D_e'	Hydraulic diameter	in. ft.
D_o		Outside tube diameter	in.
G		Mass velocity	#/sec-ft.^{2}
h_f		Fiinside oil film coefficient	Btu hr-ft.^{2} F.
h_o		h corrected for fin efficiency and referred to inside tube diameter	
h_i		Inside film coefficient based on inside tube diameter	Btu hr-ft^2-F.
h_{io}		Inside film coefficient referred to outside tube diameter	Btu hr-ft^2-F.
J		Nusselt type heat transfer factor	
j		Colburn heat transfer factor	
k		Thermal conductivity	Btu hr-ft-F.
L		Undisturbed length of bare or finned tube	ft.
N_{Nu}		Nusselt number	
N_{Pr}		Prandtl number	
N_{Re}		Reynolds number	
N_T		Number of tubes per pass	
q		Rate of heat flow	Btu hr
S		Specific gravity	
T		Bulk average temperature of fluid inside the tubes of a fintube unit	F.
	T_w	At tube wall	F.
T_N	T_N'	Total number of tubes Total number of hypothetical tubes	
t		Bulk average oil temperature	F.
	t_w	At tube wall	F.
U		Over all Heat Transfer coefficient, based on total outside surface	Btu hr-ft.^{2}-F.
	U_i	Based on A_i	Btu hr-ft.^{2}-F.
V		Oil velocity	ft/sec
W		Total oil flow	#/hr.
w		Oil flow per tube	#/hr.
Z		Dynamic viscosity at bulk average oil temp.	c.p.
	Z_w	At tube wall temperature	c.p.
Z/S		Kinematic viscosity at bulk average oil temp.	cKs
	$(Z/S)_w$	At wall temperature	cKs
		b. Greek & Composite Greek-Latin Symbols	
F		Oil flow rate, measured at bulk average temp.	Gals hr.
ΔP_f		Friction loss	psi
Δt		Temperature drop across oil film	F.
Δt_o		Over-all arithmetic mean temp. diff.	F.
Δt_{lm}		Log mean temp. diff.	F.
η		Fin efficiency	
η'		Weighted fin efficiency = $\eta\ A_f + A_b$ / A	
μ		Dynamic viscosity (in N_{Re}) (in N_{Pr})	#/sec-ft. #/hr-ft.
ϕ		$(Z/Z_w)^{0.14}$ for heat transfer $(Z/Z_w)^{0.25}$ for pressure drop	
φ		Wetted perimeter of a fin-tube	ft.
Ω		Height of a fin	ft.

The steam film is assumed to be 2000 referred to the inside surface and $U_i = 110$.

$$U = U_i \frac{A_i}{A} = 11.7$$

$$\Delta t = \frac{11.7}{14.6} \times 122 = 97.8;$$

checks assumed value

(10-C)

Applying the fouling factors 1000 and 2000 arbitrarily to the finside yields a design U of 11.5 and a required surface of 875 feet.^{2} The bare tube surface in the bends and in the straights opposite the outlet nozzle is ignored since it is small compared to the finned surface and would require independent rating.

(ii) *Pressure Loss*

$$V = 0.167 \text{ fps} \qquad (12\text{-B})$$

$$\Delta P_t = \frac{6.69 \times 10^{-4} \times .167 \times 12 \times 150}{(.875)^2\,(1.96)}$$

$= 0.134$

(11-C)

Tabulation of Results

UNIT	Design U	Surface	ΔP_t	Unit Cost
1	14	716	0.399	$1886
2	13.9	720	0.204	$1756
3	11.5	875	0.134	$2132

Comparison of the three exchangers indicates that for an equal value of U, less pressure loss results from unbaffled flow outside of a tube bundle than from flow inside the tubes. First cost favors the U-tube design with the oil on the shell side. For maintenance, the U-tube bundle is removable but tube replacement is difficult. Tube replacement is simplified with the straight tube design.

The longitudinally finned tube design offers the lowest pressure loss of the three. U, however, is also lower and the unit cost is higher.

No attempt should be made to generalize on these results. They are merely illustrative. The calculations can be performed so rapidly that all three design alternatives can be investigated for cost analysis.

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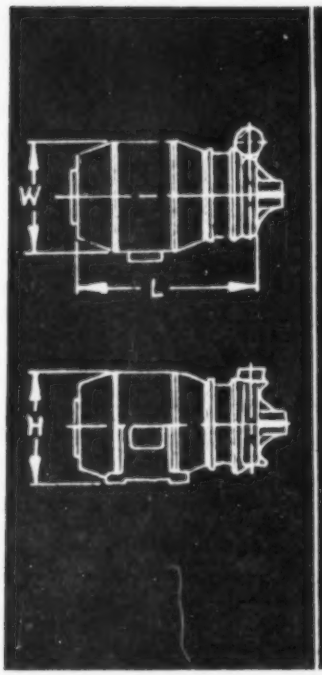

Figure 1. HORIZONTAL close coupled end suction.

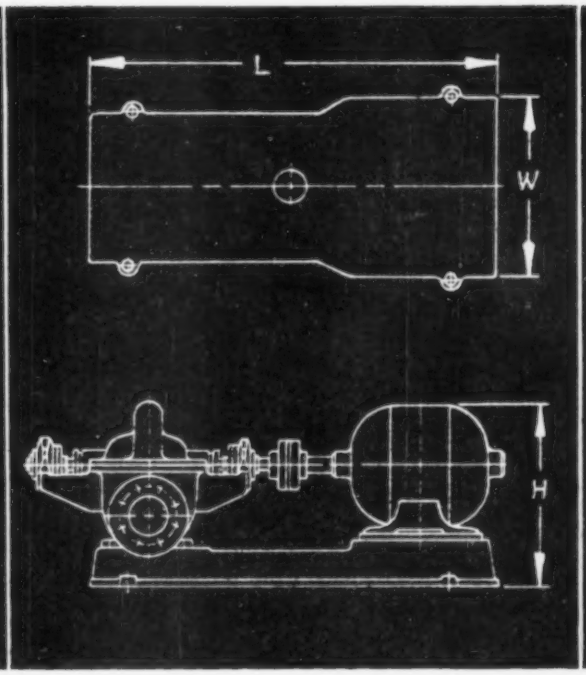

Figure 2. HORIZONTAL double suction split case.

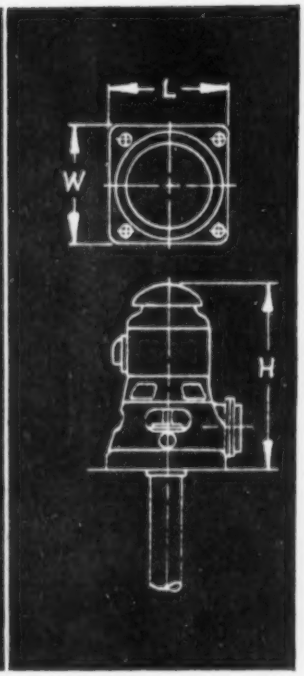

Figure 3. VERTICAL turbine pump.

TABLE 1. Space Requirements of Horizontal and Vertical Pumps

GPM	Head, Ft.	Motor, HP	Motor Speed	Fig. 1. HORIZONTAL END SUCTION				Fig. 2. HORIZONTAL DOUBLE SUCTION				Fig. 3. VERTICAL TURBINE				Area Ratio		Height Ratio	
				L	W	A_1	H_1	L	W	A_2	H_2	L	W	A_3	H_3	A_1	A_2	H_1	H_2
100	130	5	3460	$25\frac{1}{2}$	11	281	$8\frac{3}{4}$	$41\frac{1}{2}$	$16\frac{1}{2}$	685	$17\frac{7}{8}$	$12\frac{1}{2}$	$12\frac{1}{2}$	156	$27\frac{3}{8}$	1.8	4.4	3.1	1.5
150	250	15	3460	$31\frac{3}{8}$	$15\frac{7}{8}$	497	$8\frac{1}{2}$	$46\frac{3}{8}$	20	922	19	19	19	361	$36\frac{5}{8}$	1.4	2.6	4.2	2.0
300	200	20	3460	$35\frac{1}{2}$	$15\frac{7}{8}$	564	$12\frac{7}{8}$	$51\frac{7}{8}$	21	1080	21	19	19	361	$42\frac{1}{8}$	1.6	3.0	3.3	2.0
500	160	25	3460	$36\frac{3}{4}$	$16\frac{1}{2}$	606	$13\frac{7}{8}$	$51\frac{7}{8}$	21	1080	21	21	21	441	$42\frac{1}{8}$	1.4	2.5	3.1	2.0
1000	160	50	1760					$67\frac{1}{8}$	29	1945	$28\frac{1}{2}$	21	21	441	$50\frac{5}{8}$		4.4		1.8
1500	160	75	1760					$67\frac{1}{8}$	29	1945	31	23	23	529	$57\frac{3}{4}$		3.7		1.9
2000	160	100	1760					$81\frac{1}{4}$	$35\frac{1}{4}$	2860	33	31	31	961	$65\frac{3}{4}$		3.0		2.0
2500	190	150	1760					$81\frac{1}{4}$	$35\frac{1}{4}$	2860	$34\frac{7}{8}$	31	31	961	$72\frac{1}{2}$		3.0		2.1
3000	210	200	1760					$98\frac{1}{2}$	$43\frac{1}{2}$	4280	$38\frac{5}{8}$	31	31	961	$72\frac{1}{2}$		4.5		1.9
3500	225	250	1769					97	44	4275	43	38	38	1444	$77\frac{1}{4}$		3.0		1.8

NOTE: L, W, & H are expressed in inches. H = Over-all Height. A = Total Floor Area of Base Expressed in square inches.

Horizontal vs. Vertical Pumps

An engineering analysis of a controversial issue, considering these key points:

—space requirements

—NPSH, priming, flexibility

—Corrosion, maintenance

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Food Machinery & Chemical Corporation,
Los Angeles

IN MANY PUMP applications the question "should a horizontal or vertical pump be used" deserves careful study. Frequently the type of pump is dictated by the installation and there simply is no choice between the two. Perhaps the most frequent example of this is the deepwell vertical turbine type of pump used extensively for pumping water from deep wells with pump settings as much as 1000 feet below the surface. However, there are many marginal cases where either a horizontal or vertical pump could be used. In such cases it is necessary to appreciate and consider some of the inherent advantages of one type over the other so that a proper choice can

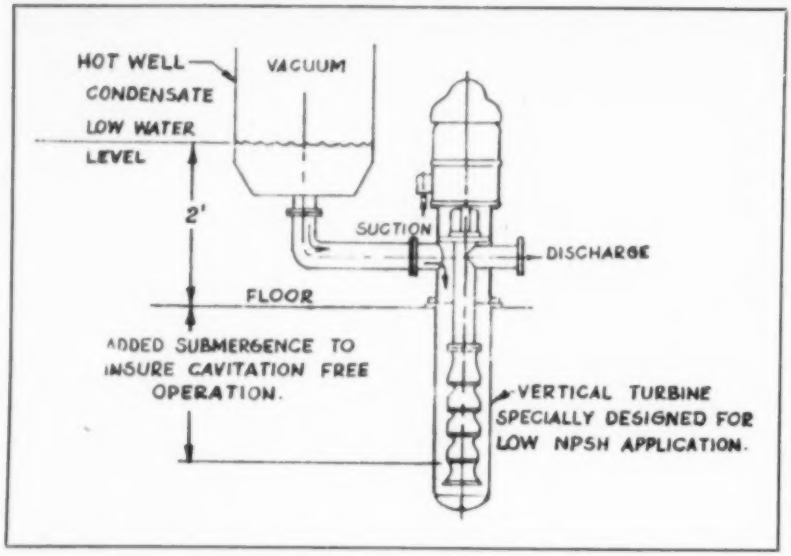


Figure 4. Application of vertical pump in condensate hot well service.

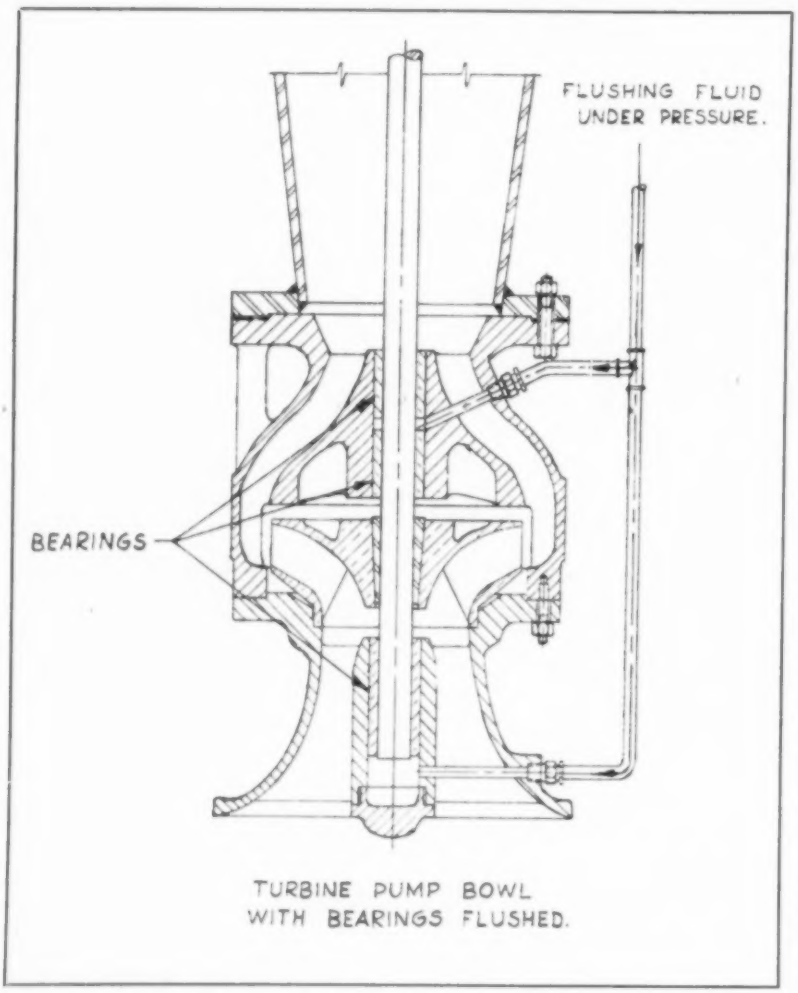


Figure 5. Vertical pump bowl designed for use of special flushing fluid.

be made. It is the purpose of this paper to point out some of the factors which should be considered if there is an opportunity to choose between using a horizontal or vertical type of pump. Because of the widespread use of the vertical turbine unit, this specific type of vertical pump will be used as a basis of comparison with horizontal centrifugal types.

Space Requirements—If available *floor* area is limited, a vertical unit generally requires less area. However, if available *headroom* is limited the horizontal unit almost invariably requires less headroom. Perhaps the best way to indicate space requirements is by typical example. It should be kept in mind that area and height requirements will differ somewhat between various manufacturers and with the type of configuration of the unit specified. Figures 1, 2 and 3, and Table 1 compare actual dimensions of horizontal with vertical pumps.

The comparison of both designs of horizontal pumps with the vertical, expressed as ratios $\left(\frac{A_1}{A_3}, \frac{H_2}{H_3}\right.$ etc.), clearly demonstrates the general order of magnitude of the area and height differences of the three types of pumps. It should be noted that the vertical turbine occupies even less floor area than the close coupled unit shown in Figure 1. In general then, consider the vertical where available area is critical and the horizontal where available headroom is critical.

Priming—Where the level of the liquid to be pumped is below the floor level, no special priming equipment is required for the vertical turbine pump since the impellers are always submerged. However, where a horizontal pump is used, some method must be used to raise the water to the impeller before the pump is started. This can be accomplished by using auxiliary vacuum pumps, air aspirators, or self priming pumps. Foot valves can also be used so that once filled, the suction pipe is kept full of liquid at all times. However, the point to keep in mind is that the vertical turbine pump is always primed or submerged and thus requires no special priming equipment or special starting procedures.

Net Positive Suction Head—In order to avoid cavitation, the net positive suction head (NPSH) *available* must be greater than the NPSH *required* by the pump. For a given set of conditions the NPSH available increases as the submergence over the

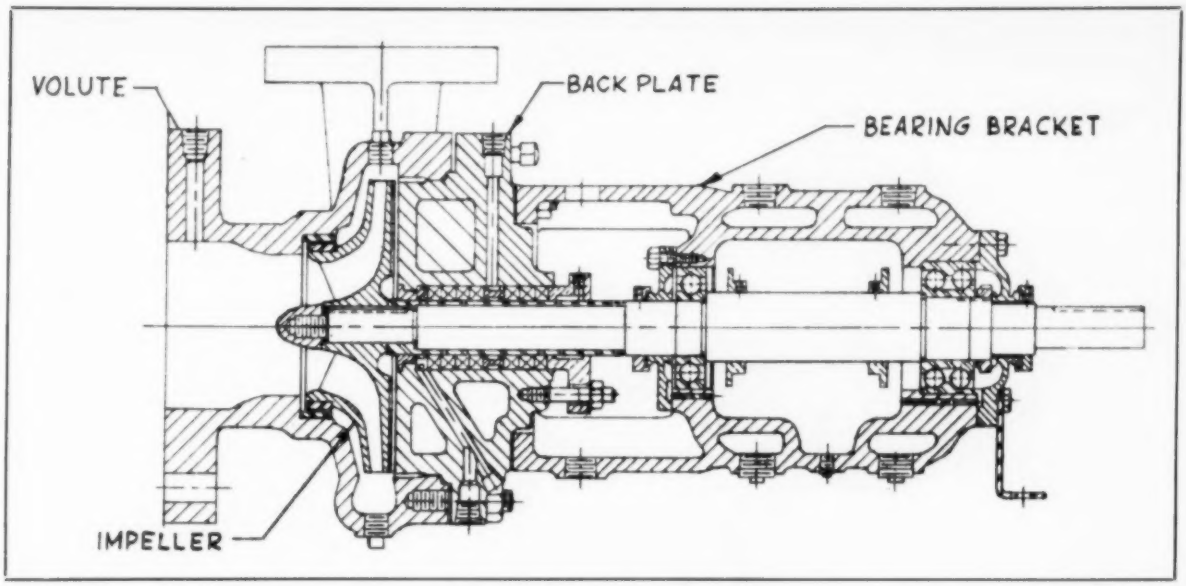


Figure 6. Typical horizontal process pump.

pump increases or if there is a suction lift, the NPSH available increases as the lift is decreased. On vertical pumps, as noted in the discussion above on priming, the suction lift is eliminated and, furthermore, it usually is a comparatively simple matter to provide enough submergence by properly selecting the length of vertical column and thus provide enough NPSH available to simplify the pump selection "cavitation-wise." In contrast to this, a given horizontal pump has no flexibility since the amount of suction lift or submergence is fixed by the plant layout. Consequently where extremely low NPSH is available the vertical pump is usually far easier to adapt than a horizontal.

A good example of this occurs frequently in the application of condensate pumps. Hotwells are often located close to the floor in order to reduce the over-all height and thus the cost of the building. However, by so doing, the NPSH available with respect to the floor is minimized. Thus it is not uncommon on condensate pump applications to have only 2 or 3 feet NPSH available with respect to the floor. It can be seen from Figure 4 that by using a vertical pump enough submergence can be added to the 2 or 3 feet to insure cavitation-free operation.

In addition to the example just discussed, other common applications occur where NPSH is critical such as pumping highly volatile fluids (propane, ammonia, etc.). Also, there are installations where hydraulic losses in the suction pipe leading to the pump are sufficiently high to reduce the absolute pressure of the fluid to a point where it is one or two pounds over the vapor pressure, thus normally requiring a vertical to increase the submergence or NPSH available.

Flexibility—Where changes in pumping heads are anticipated because of plant expansion, changes in a process, or transfer of the pump to a different service, it is relatively easy and inexpensive to add or remove stages from a vertical turbine type pump in order to meet the new conditions. Many users recognize the limitation of the horizontal type of pump in this respect and partially compensate for this shortcoming by specifying on new equipment that full diameter and minimum diameter impellers are not acceptable. It should be recognized that this practice can sometimes mean that the manufacturer, to avoid using a full diameter impeller, is forced to select a pump larger than necessary to meet the initial conditions and in some cases a less efficient pump. Thus, both initial and operating costs are increased in some cases, in order to have a unit which is capable of an increase in head by substituting a full or larger diameter impeller, if and when the need arises. Vertical turbine pumps, however, can be staged and destaged relatively easily. Where increased heads are anticipated, the vertical turbine can be built so that additional stages can be added in the future, often with little expense compared with the initial cost of the unit. This usually means furnishing the pump initially with sufficiently large shafting and motor base to accommodate the increased future horsepower. Where the head is decreased, it is a simple matter to destage the bowl unit.

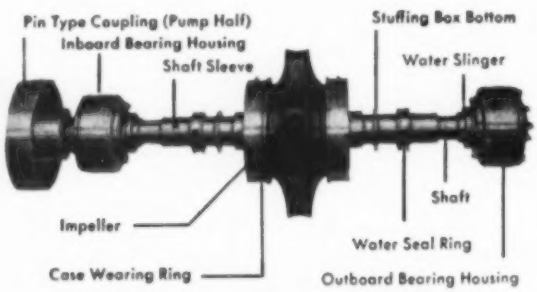
Corrosion and Abrasion—The high cost of repair and down time on many pumps which are applied on corrosive and/or abrasive applications is well known to operating personnel. On vertical turbine pumps the bearings are lubricated by the fluid being pumped. This is a distinct disadvantage when compared with horizontal centrifugal units where the pump bearings are usually if not always oil or grease lubricated and are completely isolated from the fluid being pumped.

It is true that vertical turbine process pumps have been successfully applied for corrosive fluids by using special bearing materials such as teflon, graphitar, boron carbide, babbitt and meehanite. It is also true that in severe abrasive service the bearings can be flushed by a clean non-corrosive fluid provided the process fluid will not be contaminated by the flushing fluid. Such a design is shown in Figure 5. However, use of special bearing lubrication or materials means special non-standard equipment with relatively high initial costs and longer delivery. Therefore, where other considerations are equal, the horizontal pump "bearing-wise" has a distinct advantage over the vertical turbine where severe abrasion and/or corrosion is to be expected.

Figure 6 pictures a horizontal-type process pump. Note the entire bearing bracket is isolated from the fluid being

Horizontal vs. Vertical Pumps . . .

View of double-suction, horizontally split, horizontal pump



View showing complete rotating element

FIGURE 7

pumped by means of the backplate. This type of design means that only the shaft, volute, impeller and backplate need be made of corrosion resistant material, with the bearing bracket usually made of inexpensive material such as cast iron. In contrast to this, all parts of the vertical turbine are exposed to the fluid and consequently must be made of suitable material throughout in order to resist corrosive attack. Thus, in addition to the bearing problem, a vertical turbine process pump made out of high alloy materials is considerably more expensive than a horizontal process pump made with the same high alloy and designed for the same service.

Inspection and Repair—In general, the horizontal pump is far more accessible for inspection, maintenance and repair than the vertical turbine pump. There are undoubtedly exceptions to this, plus the fact that ease of maintenance of various types of horizontals will vary considerably. However, to inspect a turbine pump bowl the motor, motor base, and column all must be removed before the bowl can be disconnected from the column to which it is attached. In contrast to this, for example, is the double suction, horizontally split, horizontal pump. Figure 7 pictures such a pump, with the upper half of the case removed thus allowing the complete rotating unit to be visually inspected and removed if necessary. Neither the piping nor the motor need be disturbed to remove the rotating element. There are also vertically split horizontal pumps designed so that it is unnecessary to disturb the motor or piping in order to remove the rotating assembly.

Conclusions—Besides the characteristics of the pump itself, there are certainly other factors which influence the choice of pumping equipment, not the least of which is the design and configuration of the plant equipment and layout, with which the pump must be coordinated. Other factors such as safety regulations will affect the choice of pumping equipment. For example, in order to avoid side outlets in the storage tank it is normally good safety practice on above ground tanks to use vertical wet pit pumps when pumping oleum. But even where well defined factors such as these do not pre-determine the choice of pump types, it is a mistake to make any hard and fast rules about the selection of a horizontal over a vertical or vice versa. Often in marginal cases, where new equipment is being considered, it would be expedient to obtain quotations on both horizontal and vertical types. Each application must be judged on its own merits, keeping in mind the basic advantages and disadvantages of each type, as outlined above.

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Vapor-Liquid Equilibrium Ratios

Part I. The general method applied to binary systems

Part II. Ternary and multicomponent systems

• The convergence pressures of multicomponent mixtures may be easily calculated by this method.

J. M. Lenoir and G. A. White, C. F. Braun & Co., Alhambra, Calif.

THE USEFULNESS of convergence-pressure for predicting equilibrium-ratios depends largely on the ease of computing convergence-pressures. The authors have developed a method of using hypothetical binaries to represent ternary and multicomponent mixtures. This approach has been suggested by Katz and Kurata[11]* as a convenient way to handle complex mixtures.

The advantage of the concept is that for binary mixtures, the locus of convergence-pressures coincides with the locus of critical temperatures and pressures. Thus the convergence-pressure of a hypothetical binary depends only upon the critical locus of the two components chosen to represent the mixture.

Figure 12 shows the essential difference between critical and convergence-pressures. Point A represents a binary mixture at a given temperature and pressure. The line AP, is the projection of the operating-pressure, at con-

* All references appear at end of Part I, used in Petroleum Refiner, October, 1953.

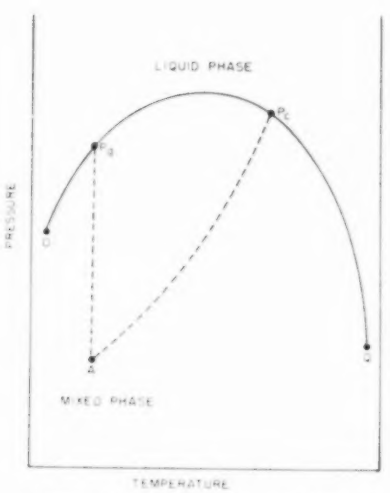


Figure 12. Convergence-pressure locus

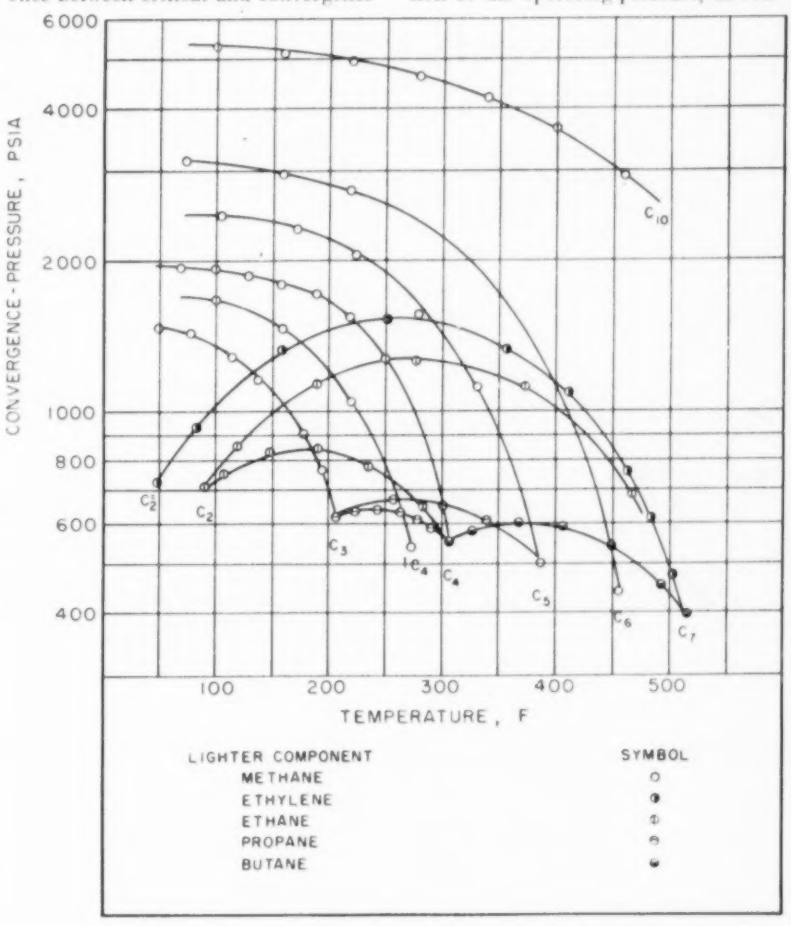


Figure 13. Convergence-pressures for binary hydrocarbon systems

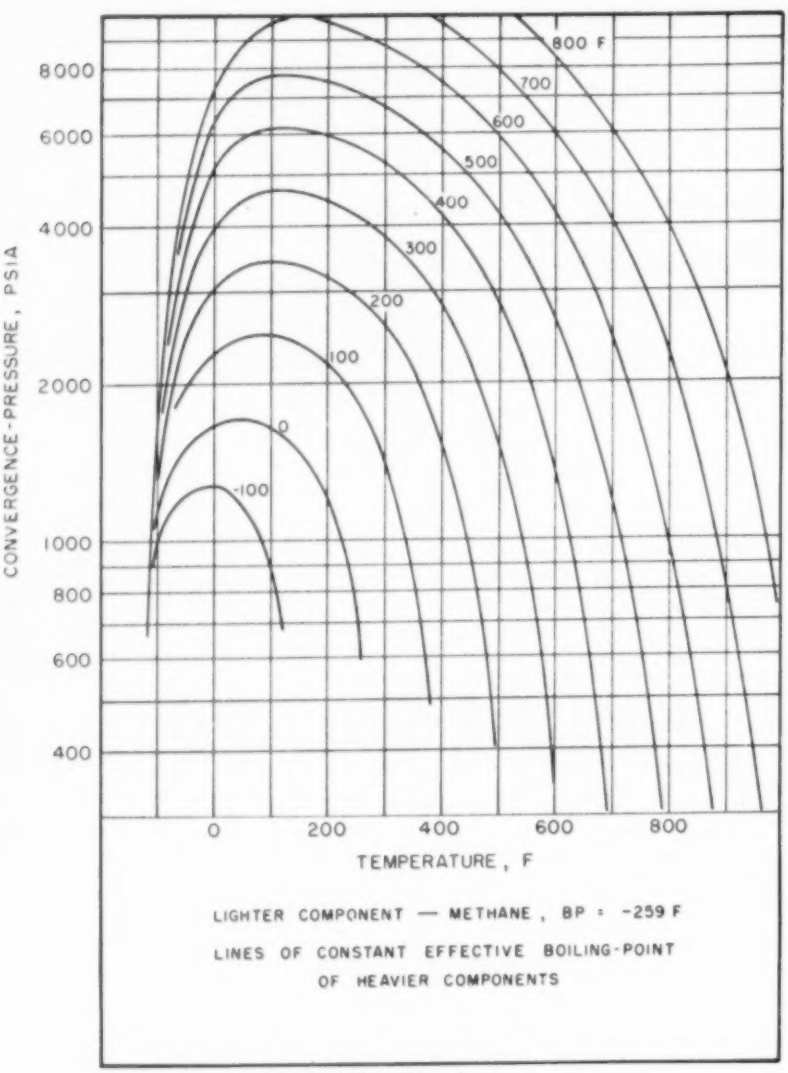


Figure 14. Convergence-Pressure

stant composition, to the critical-pressure p_c. The line AP_g is the isothermal projection of the operating-pressure to the convergence-pressure, p_g. At the convergence-pressure, the equilibrium-ratio of each component in the mixture is unity.

Experimental data from literature were used to establish the critical loci for n-paraffins and olefins, as in Figure 13. Mayfield's[24] correlation of true critical-pressure was used to supplement the literature data. Generalized convergence-pressure curves were then constructed as shown in Figures 14 and 15. These curves are drawn for methane and for ethane as the lighter components of the binaries. Each curve is identified by the boiling-point of the heavier component at atmospheric pressure.

Complex mixtures can be regarded as composed of two hypothetical components. Each of the hypothetical components is identified by an effective boiling-point. These effective boiling-points are computed from the normal boiling-points of the compounds in the mixture, by an empirical method.

Ternary mixtures were chosen to develop the method for predicting effective boiling-points for hypothetical binaries. Tables 1, 2, and 3 show the data for four of the systems that were used to establish the empirical correlation. Experimental data for mixtures having a high concentration of the lightest compound in the liquid-phase were used to study the performance of the two heavier compounds. For this case, the normal boiling-point of the lightest compound was used as the effective boiling-point of the lighter hypothetical or representative component. And the intermediate compound was assumed to have contributed only to the effective boiling-point of the heavier representative component. It was found that the intermediate compound does not contribute as much as the heaviest compound to the effective boiling-point of the heavier component of the hypothetical binary.

TABLE 1

Methane-Propane-Pentane System

Multiplying-Factor for Propane in Computing the Heavier Component Effective Boiling-Point

Ratio $\frac{C_3}{C_3+C_5}$	Temperature, F.	Experimental Convergence—Pressure, psia.	EBP_H, F.	Multiplying-Factor F_e
0.2	160	2200	89	0.55
0.4	160	1990	58	0.57
0.6	160	1750	30	0.60
0.8	160	1420	— 6	0.67
0.2	220	1950	79	0.58
0.4	220	1750	60	0.54
0.2	100	2290	79	0.58
0.4	100	2150	63	0.49
0.6	100	1860	27	0.65
				0.58

Data at 160 and 220 F. from Dourson, Sage, and Lacey[9]. At 100 F. from Carter, Sage, and Lacey[2].

TABLE 2

Methane-Butane-Decane System[28, 31]

Multiplying-Factor for Butane in Computing the Heavier Component Effective Boiling-Point

Ratio $\frac{C_4}{C_4+C_{10}}$	Temperature, F.	Experimental Convergence—Pressure, psia.	EBP_P, F.	Multiplying-Factor, F_e
0.4	160	4500	286	0.35
0.6	160	3900	240	0.34
0.8	160	2890	150	0.39
0.2	280	4380	320	0.35
0.4	280	3920	287	0.34
0.6	280	3260	236	0.36
				0.35

TABLE 3

Multiplying-Factors for Highly Volatile Systems[2, 3]

Liquid-Phase Mole Fractions			Temperature, F.	PRESSURE, psia.		EBP_H, F.	Multiplying-Factor, F_e
C_1	C_2	iC_4		System	Convergence		
0.284	0.1705	0.5455	100	1000	1570	— 8	0.41
0.2175	0.181	0.6015	160	1000	1400	—10	0.48
C_1	C_2	C_5					
0.599	0.140	0.261	100	2000	2150	+60	0.36

Table 1 shows the contribution of propane to the effective boiling-point of the heavier representative component in a methane-propane-pentane mixture. The hypothetical binary is composed of methane as the lighter component and a mixture of propane and pentane as the heavier component. The effective boiling-point of the heavier component was determined from convergence-pressure curves as shown in Figure 13. This was done by using the boiling-point of methane, the convergence-pressure, and the operating-temperature to identify the binary convergence-pressure curve that represents the system. The contribution of propane to the effective boiling-point of the heavier component was found from experimental data to be less than proportional to the mole fraction. The mole fraction must be multiplied by a factor to get the contribution of the intermediate compound to the effective boiling-point of the heavier component. The multiplying factor, F_c, is independent of temperature, pressure, and relative amounts of propane and pentane in the mixture.

Table 2 shows similar results for the system methane-butane-decane. And Table 3 shows the results for two mixtures of methane-ethane-isobutane and for one mixture of methane-ethane-pentane. Figure 16 is a plot of the factor F_c against the ratio of the boiling-points of the two heavier components. This straight-line correlation on log-log paper represents the experimental data from four systems within about seven percent. The correlation is used to predict the effective boiling-point of the heavier representative-component in ternary mixtures.

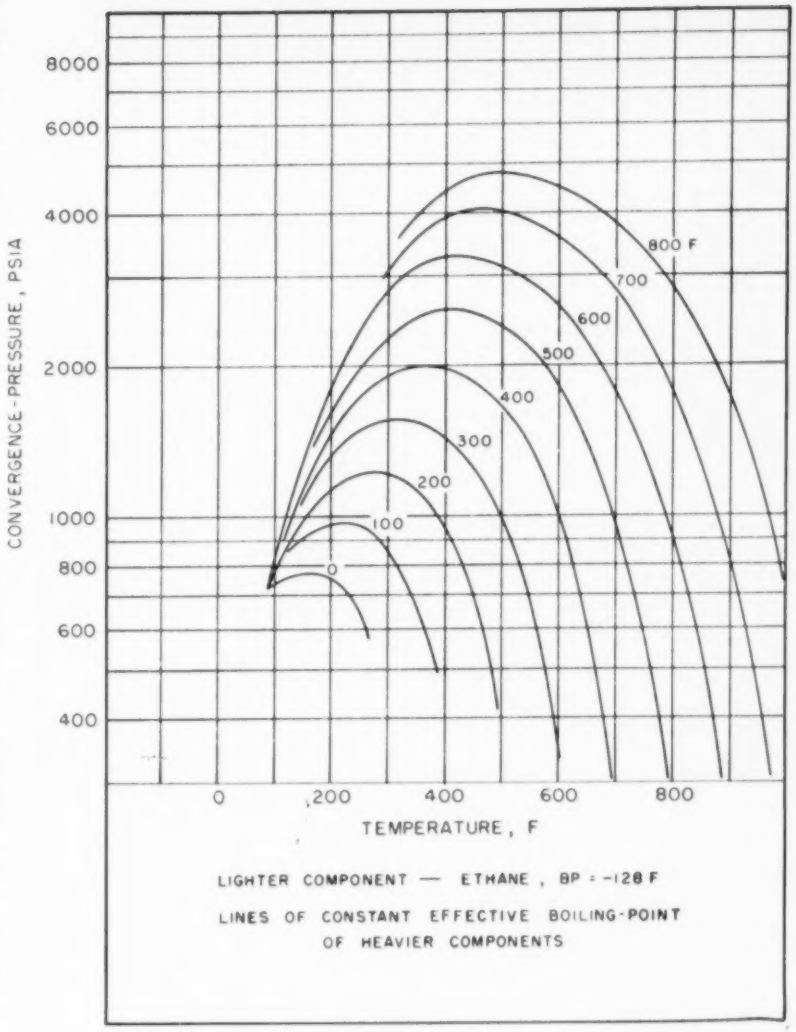


Figure 15. Convergence-pressure

TABLE 4

METHANE-ETHYLENE-ISOBUTANE SYSTEM

Multiplying-Factor for Ethylene in Computing Effective Boiling-Point of Lighter Component

Liquid-Phase Mole Fractions				Pressure, psia.	Temp., F.	EBP_H, F.	P_c, psia.	EBP_L, F.	Multiplying-Factor, F_c
C_1	C_2	iC_4	K_{C_1}						
0.1253	0.1245	0.752	0.265	500	100	0	1600	—253	0.062
0.069	0.279	0.652	0.281	500	100	—14	1380	—237	0.066
0.252	0.270	0.478	0.316	1000	100	—20	1450	—252	0.067
0.2155	0.3835	0.401	0.363	1000	100	—35	1340	—248	0.066
0.189	0.462	0.349	0.408	1000	100	—47	1230	—244	0.069
0.1575	0.563	0.2795	0.499	1000	100	—64	1120	—243	0.063
0.159	0.344	0.507	0.609	1000	160	—25	1190	—247	0.062
0.1135	0.4585	0.428	0.748	1000	160	—40	1040	—239	0.059
									0.064

Methane-Ethane-Pentane System

Liquid-Phase Mole Fractions				Pressure, psia.	Temp., F.	EBP_H, F.	P_c, psia.	EBP_L, F.	Multiplying-Factor, F_c
C_1	C_2	C_5	K_{C_1}						
0.0417	0.575	0.383	4.79	500	100	18	1650	—244.5	0.090
0.188	0.650	0.163	1.85	1000	100	—36	1250	—234	0.069
0.220	0.468	0.312	2.39	1000	100	19	1520	—232	0.122
0.414	0.352	0.235	1.50	1500	100	19	1720	—251	0.077
0.415	0.234	0.351	1.79	1500	100	56	1980	—253.5	0.084
									0.088

Experimental data for ternary systems having a preponderance of the heaviest component in the liquid-phase are not available in the literature. It was necessary to use the established correlation for predicting the effective boiling-point of the heavier component as a base, to develop a correlation for the lighter-component boiling-point. The approach to a correlation followed the same course as outlined for the heavier component.

Table 4 shows the results of the computations on several mixtures of the system methane-ethane-isobutane, and on several mixtures of the system methane-ethane-pentane. Figure 17 shows a plot of the multiplying-factor, F_c, against the ratio of the boiling-points of the lightest component to the intermediate component. Data for two systems define the position of the curve. A straight-line correlation on log-log paper is consistent with the

correlation for the effective boiling-point for the heavier component. Figure 17 is used to compute the effective boiling-point of the lighter component in ternary systems.

The application of the method, developed from data on binary and ternary mixtures, has been extended to multicomponent mixtures. All components other than the lightest and heaviest in multicomponent mixtures, are considered intermediate components. The multiplying factors on Figures 16 and 17 are used to compute the contribution of each compound to the effective boiling-points. The computation procedure for a multicomponent paraffinic-mixture is shown in the example that follows the section, "Conclusions."

TABLE 5

Comparison of Predicted and Experimental Equilibrium-Ratios

System and Reference	Ref.	Temp., F.	PRESSURE, psia. System	PRESSURE, psia. Convergence	Component	Liquid Mole Percent	EQUILIBRIUM-RATIOS Experimental	Authors	S & W[12]	Benedict[1]
Methane-Ethane	34	32	880	1160	C_1	23.5	1.74	1.80	1.58	1.53
					C_2	76.5	0.77	0.77	0.80	0.81
		−109	558	780	C_1	73.5	1.28	1.37		1.22
					C_2	26.5	0.23	0.235		0.151
		−155	147	1700	C_1	35.0	2.7	2.8		1.98
					C_2	65.0	0.09	0.06		0.078
Methane-n-Butane	36	220	400	1490	C_1	4.8	6.82	6.7	7.00	6.2
					nC_4	95.2	0.71	0.68	0.74	0.69
		190	300	1680	C_1	3.9	9.33	9.3	9.60	9.05
					nC_4	96.1	0.66	0.69	0.68	0.70
		100	1700	1900	C_1	55.9	1.51	1.48	1.43	1.53
					nC_4	44.1	0.36	0.40	0.49	0.433
		250	1000	1200	C_1	21.9	1.98	1.95	1.61	1.87
					nC_4	78.1	0.73	0.76	0.90	0.75
Ethane-n-Heptane	15	133	200	930	C_2	26.5	3.69	3.6	3.50	3.67
					nC_7	73.5	0.030	0.034	0.031	0.034
		71	400	1200	C_2	77.1	1.29	1.32	1.31	1.32
					nC_7	22.9	0.0089	0.0085	0.0110	0.0175
		411	800	930	C_2	33.4	1.80	1.60	1.75	1.75
					nC_7	66.6	0.60	0.60	0.71	0.80
Ternary	3	100	500	1665	C_1	5.5	5.00	5.1	4.90	4.85
					C_2	51.4	1.33	1.38	1.35	1.28
					nC_5	43.1	0.102	0.096	0.094	0.10
		100	2000	2150	C_1	59.9	1.27	1.26	1.28	1.27
					C_2	14.0	0.86	0.88	0.91	0.89
					nC_5	26.1	0.44	0.46	0.36	0.46
Ternary	7	100	500	2150	C_1	14.7	5.41	5.4	5.45	5.55
					C_3	32.4	0.51	0.525	0.56	0.51
					nC_5	52.9	0.076	0.072	0.070	0.068
		100	2000	2150	C_1	63.1	1.26	1.26	1.24	1.28
					C_3	14.9	0.65	0.70	0.93	0.71
					nC_5	22.0	0.48	0.44	0.39	0.46
		160	1000	1990	C_1	27.2	2.89	2.9	2.88	3.0
					C_3	28.7	0.57	0.61	0.65	0.59
					nC_5	44.1	0.18	0.183	0.187	0.16
Multicomponent	13	100	517	2250	C_1	14.8	5.68	5.6	5.37	5.45
					C_2	4.4	1.51	1.4	1.37	1.34
					C_3	8.1	0.41	0.50	0.55	0.48
					C_4	15.2	0.175	0.185	0.154	0.18
					C_5	57.5	0.060	0.068	0.061	0.068
		100	1736	2110	C_1	52.5	1.56	1.55	1.60	1.61
					C_2	7.3	0.84	0.82	0.87	0.83
					C_3	6.0	0.48	0.53	0.63	0.52
					C_4	8.4	0.33	0.35	0.31	0.32
					C_5	25.8	0.21	0.23	0.21	0.22
		100	1639	2215	C_1	45.1	1.74	1.70		1.75
					C_2	13.1	0.78	0.80		0.83
					C_3	14.9	0.48	0.51		0.50
					C_5	12.6	0.16	0.17		0.18
					C_6	14.3	0.11	0.105		0.12
Multicomponent	32	200	1700	8100	C_1	28.9	3.17	2.9	3.16	2.86
					C_2	3.3	1.20	1.22	1.13	1.11
					C_3	2.9	0.59	0.65	0.90	0.58
					C_4	3.4	0.35	0.36	0.35	0.31
					C_5	3.2	0.19	0.20	0.175	0.15
					C_6	5.3	0.085	0.11	0.096	0.082
					C_7+	53.0				
		200	2500	8400	C_1	40.0	2.28	2.15	2.21	2.03
					C_2	3.9	1.01	1.05	1.02	0.95
					C_3	3.0	0.56	0.64	0.94	0.56
					C_4	3.1	0.39	0.40	0.43	0.35
					C_5	2.8	0.29	0.27	0.25	0.19
					C_6	3.9	0.128	0.16	0.16	0.11
					C_7+	43.3				
		200	4957	9000	C_1	59.4	1.49	1.50	1.24	
					C_2	4.1	0.97	1.05	0.85	
					C_3	2.4	0.79	0.85	0.99	
					C_4	2.3	0.63	0.69	0.68	
					C_5	1.8	0.49	0.54	0.53	
					C_6	2.2	0.41	0.45	0.44	
					C_7+	27.8				

TABLE 6

Component	Boiling-Point, R	Temp. Ratio	Factor F_x	Mole Fraction x	$F_x x$	$F_x x T$
C_1						
C_2	332	0.540	0.29	0.1222	0.0355	11.8
C_3	416	0.676	0.45	0.1369	0.0615	25.6
C_5	557	0.905	0.82	0.0851	0.0699	39.0
C_6	615	1.00	1.00	0.0984	0.0984	60.5
					0.2653	136.9

The results in Table 5 show the importance of composition in the prediction of equilibrium-ratios at high pressures. The effects of composition can be accounted for by the use of convergence-pressures. Ternary and multicomponent mixtures can be treated as

The lightest and the heaviest compounds in the liquid-phase are the key components in determining effective boiling-points. The lightest compound contributes only to the effective boiling-point of the lighter representative-component. And the heaviest compound contributes only to the effective boiling-point of the heavier representative-component. The intermediate compounds contribute to the effective boiling-points of both representative components, but in an amount that is less than proportional to their mole fractions. The lightest and heaviest compounds contribute more than in proportion to their mole fractions in the liquid-phase. Thus, convergence-pressure is not usually dependent upon changes in liquid-phase composition from tray to tray in a distillation-column. For many distillation-columns, one convergence-pressure may be used to compute equilibrium-ratios throughout the column.

Table 5 is a comparison of equilibrium-ratios predicted by this method, with experimental values. The table also includes equilibrium-ratios computed by the methods of Smith and Watson[12] and Benedict.[1] For this comparison, the multicomponent systems were limited to paraffin and olefin hydrocarbons. The computed equilibrium-ratios are within an average accuracy of some six percent of experimental data.

The method is applicable to petroleum fractions identified only by gravity and boiling-range as well as to mixtures of known composition. But a description of the procedure for hydrocarbons of unknown composition is beyond the scope of the present article.

Conclusions

The approach to equilibrium-ratios through convergence-pressure, offers a direct solution to problems of vapor-liquid equilibrium. And the absolute values of convergence-pressure are not always critical to the computation of equilibrium-ratios. For many distillation-columns, the convergence-pressures of the overhead and bottoms streams, may be used to compute equilibrium-ratios throughout the column.

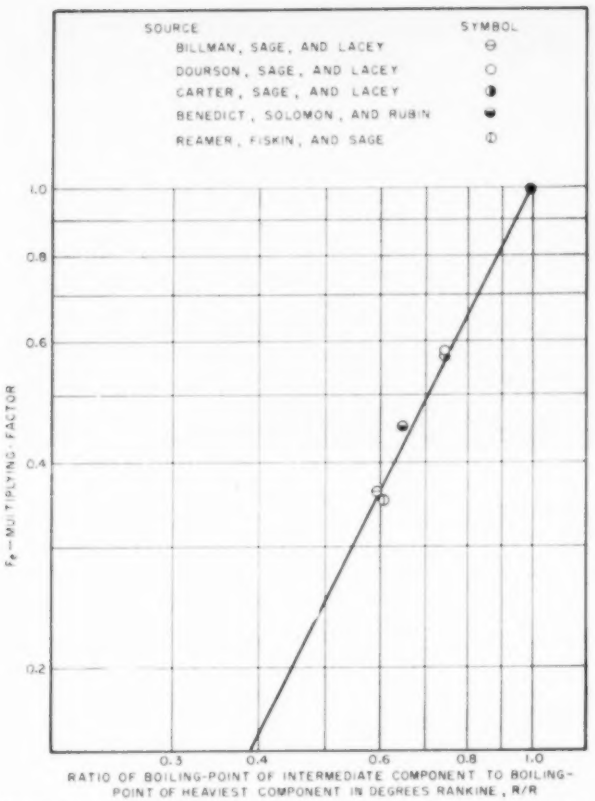


Figure 16. Multiplying-factors for computing effective boiling point of the heavier component

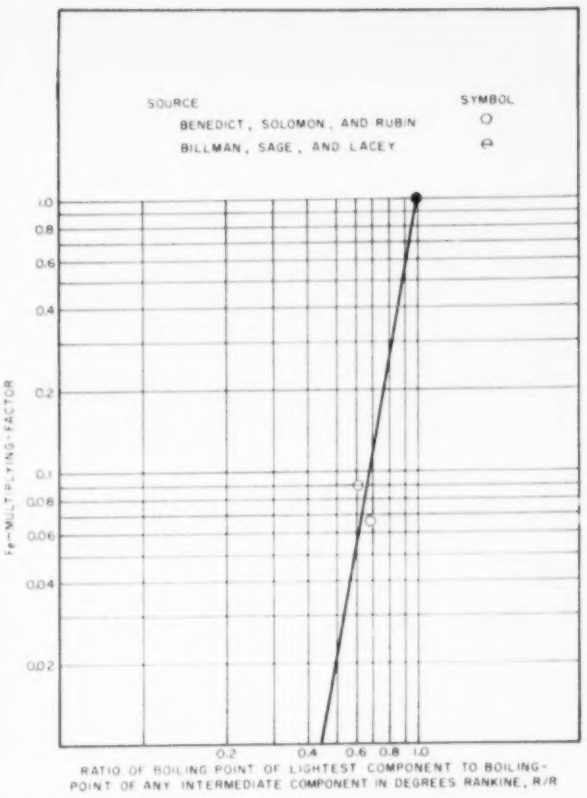


Figure 17. Multiplying-factors for computing effective boiling point of the lighter component

hypothetical binaries for predicting equilibrium-ratios.

For operations near the critical-pressure, small changes in the convergence-pressure may affect the equilibrium-ratios appreciably. For this case, a crossplot of equilibrium-ratio at 10 psia against equilibrium-ratio at the operating-pressure for constant convergence-pressures, greatly simplifies the solution.

Example

The convergence-pressure of a mixture is computed from the composition of the liquid-phase. In one case, the liquid-phase composition is known to be 0.577 mole-fraction methane, 0.122 mole-fraction ethane, 0.137 mole-fraction propane, 0.085 mole-fraction n-pentane, and 0.098 mole-fraction n-hexane. The equilibrium-ratio of each component is needed at 100 F. and 1822 psia. Figure 11 is used to get the equilibrium-ratios at 10 psia and 100 F.

Component	K_{10}
C_1	285
C_2	55
C_3	17
n-C_5	1.8
C_6	0.5

The effective boiling-points of the representative binary-components are computed by using Figures 16 and 17 to get the fractional contribution of each component. The lightest individual component is not considered a part of the heavier-component boiling-point. And the heaviest individual component is not included in computing the lighter-component boiling-point. Relative values of the mole-fractions are used to compute the effective boiling-points. There is no need to adjust the mole-fractions for the absence of the lightest and heaviest compounds.

A summary of the data and computations are shown in Tables 6 and 7.

The heavier component effective

$$\text{boiling-point} = \frac{136.9}{265.3} = 515 \text{ R} = 55 \text{ F.}$$

The lighter component effective boiling-point

$$= \frac{114.8}{565} = 203 \text{ R} = -257 \text{ F.}$$

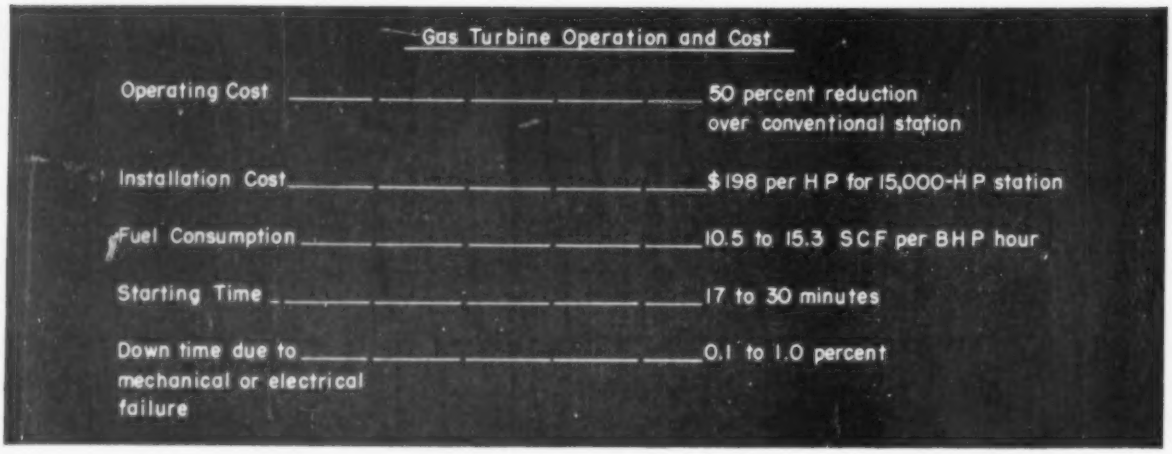
For a lighter-component boiling-point of minus 257 F. and a heavier-component boiling-point of 55 F., a convergence-pressure of 2150 psia is found on Figure 14. A linear interpolation between the general figures, Figure 6 through 10, for each component, gives the results found in Table 8. Experimentally-measured data of Hanson and Brown[13] are included.

TABLE 8

Component	K Predicted	K Measured
C_1	1.40	1.37
C_2	0.85	0.84
C_3	0.61	0.57
n-C_5	0.33	0.36
C_6	0.25	0.25

TABLE 7

Component	Boiling-Point, R	Temp. Ratio	Factor F_e	Mole Fraction x	$F_e x$	$F_e x$ T
C_1	201	1.00	1.00	0.5574	0.5574	112.0
C_2	332	0.605	0.05	0.1222	0.0062	2.0
C_3	416	0.482	0.012	0.1369	0.0016	0.7
C_5	557	0.361	0.002	0.0851	0.0002	0.1
C_6						
					0.5653	114.8


Gas Turbine Operation and Cost
Operating Cost
50 percent reduction over conventional station
Installation Cost
$198 per H P for 15,000-H P station
Fuel Consumption
10.5 to 15.3 S C F per B H P hour
Starting Time
17 to 30 minutes
Down time due to mechanical or electrical failure
0.1 to 1.0 percent

Take another look at . . .

Gas Turbines

How are they doing?
Here are the experiences of four companies

ECONOMICAL maintenance and low operating costs have been experienced by four companies in the use of gas turbines.

El Paso Natural Gas Company has 19 gas turbines which have logged more than 200 million bhp hours. El Paso will have nine more such units when the present construction is completed.

Oklahoma Gas and Electric Company has two natural gas turbines in service, one of which is said to have compiled more operating time than any other gas turbine in the world.

Atlantic Seaboard Corporation placed a 5000-horsepower gas turbine in operation on January 30, 1953.

Mississippi River Fuel has used an 1850-horsepower turbine since the spring of 1949. This unit was originally design to burn oil but has been converted to gas.

How are they doing?

Here are the companies' experiences:

Maintenance

The over-all cost of maintenance on these turbines has been less than was originally expected. Oklahoma Gas & Electric's costs in this line have run about $0.82 per horsepower (summer capacity). It expects this figure to be lowered to some point between $0.67 and $0.75 in the near future.

Most of the maintenance problems faced by El Paso Natural Gas in the operation of its units have been in connection with the control accessories rather than with the turbines themselves. Notable exceptions to this are oil leaks and water carryover from the air pre-coolers. Both of these problems have been under the close scrutiny of El Paso's engineers and successful solutions are expected in the near future. Maintenance downtime on these 19 gas turbines has run from as much as two and one-half percent on the new units to less than one percent on the older ones.

Operation

Perhaps the most significant item of interest in the use of gas turbines is the lowering of operating costs. El Paso Natural Gas shows a 33⅓ percent reduction in operating costs under the operating costs of a conventional station. For those who have been accustomed to steam turbines and boilers, the starting time of from 17 to 30 minutes for gas turbines will come as somewhat of a shock.

Fuel consumption of these turbines has been from 10 to 15 scf per bhp hour.

Of the turbines presently in use, only one has had what would be termed a major failure. This occurred on February 22, 1952, when a blade failed on a turbine operated by Mississippi River Fuel Corporation. Due to this failure the rotor and stator blading was destroyed. Following field repairs, the unit was placed back in operation and continued in service for eight months when a shutdown was made to install a new disc type rotor. It is still in service today.

Costs

Recent figures of El Paso Natural Gas Company show an installed cost of $198 per horsepower for a 15,000-horsepower gas turbine station.

This cost does not include such items as site improvements, station and camp water supply, camp facilities, mainline piping, general overhead, and undistributed field costs. These costs have been omitted, in the interest of comparison since other companies might feel that their costs in these particular items would not correspond to El Paso's. It does, however, include such items as high pressure piping systems, water treating buildings, etc., which would not be included should the turbine be installed in a refinery.

Operating costs, which include maintenance, operation, administration, taxes, interest, insurance, depreciation, etc., are 50 percent higher for a conventional station than for a gas turbine station.

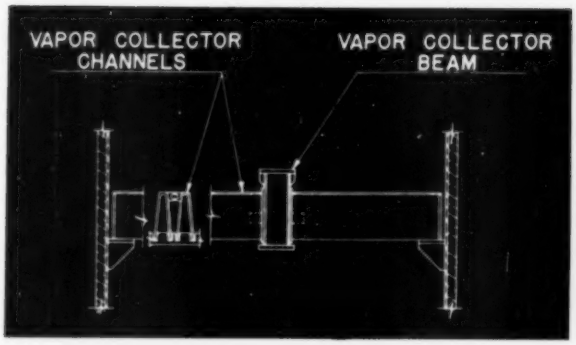


Figure 1. Reactor-vapor disengager, type No. 1

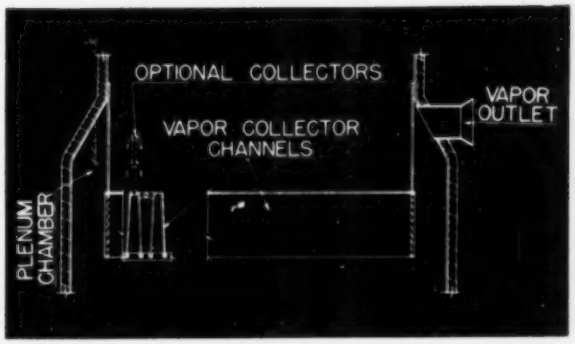


Figure 2. Reactor-vapor disengager, type No. 2

New Design Features of Houdriflow

Vast improvements have been made in the design of modern Houdriflow units. Here are the details on

—Reactor vapor disengager

—Kiln air distributor

—Kiln cooling coils

—Kiln withdrawal sections

R. M. Shirk and D. B. Ardern, Houdry Process Corporation, Philadelphia

THE HISTORY of the development of catalytic cracking in the petroleum industry is packed with examples of the achievements obtained through effective coordination of both process and mechanical development. As new processing principles and concepts have evolved, new mechanical designs have been required, and many very interesting mechanical problems have been encountered and solved.

Catalytic cracking is, broadly, the process of contacting gas oil fractions of crude oil with active catlyst under suitable conditions so that 50-60 percent of the gas oil charge is converted into gasoline in a single pass operation. As the cracking reactions take place, a carbonaceous deposit is left upon the catalyst, which greatly decreases its activity. However, the coke deposit can be removed by combustion and the catalyst activity is thereby restored so that the catalyst may be used again in the cracking operation.

Houdry Process Corporation's catalytic cracking processes use catalysts which are in the form of solid cylindrical or spherical pellets approximately one-eighth of an inch in diameter. The use of such catalysts in a moving bed system was first applied to the Houdry catalytic cracking process on a commerical scale in 1943. Houdry now licenses a more advanced embodiment of the moving bed system known as Houdriflow catalytic cracking. Some of the related process and mechanical problems encountered in the development of moving bed units, and the mechanical features embodied in the solution of these problems in present Houdriflow designs, are the subject matter of this discussion.

Moving Bed Technique

The two basic operations required in catalytic cracking are the chemical reactions or cracking of the oil charge and the combustion of the coke deposit on the catalyst. In processes utilizing the moving bed techniques these two operations are carried on continuously in separate sections of the system. The catalyst is moved at a controlled rate in a steady stream successively through the cracking and regeneration sections. The regenerated catalyst is returned to the reactor.

The first form of the moving bed process employed two separate vessels, identified as the reactor and the regenerator, or kiln. Mechanical bucket elevators were used to raise the catalyst from the bottom of one vessel to the top of the other vessel. In the latest Houdriflow designs the reactor is superimposed over the kiln and the two are built as a common vessel. The catalyst is transported from the bottom of the kiln to the top of the reactor by a pneumatic lift system.

An underlying concept of the moving bed technique is that the catalyst flows downward through the vessels as a solid gravitating mass. Both the hydrocarbon charge and the regeneration air must be properly engaged or distributed into the moving catalyst bed and then disengaged or separated from the catalyst pellets for removal from the reactor-kiln vessel. These operations are accomplished preferably with minimum disturbance to the flow of the solids and with maximum uniformity in distribution of the vapors in the catalyst bed.

A considerable portion of the heat

MAINTENANCE / OPERATION

New Design Features of Houdriflow . . .

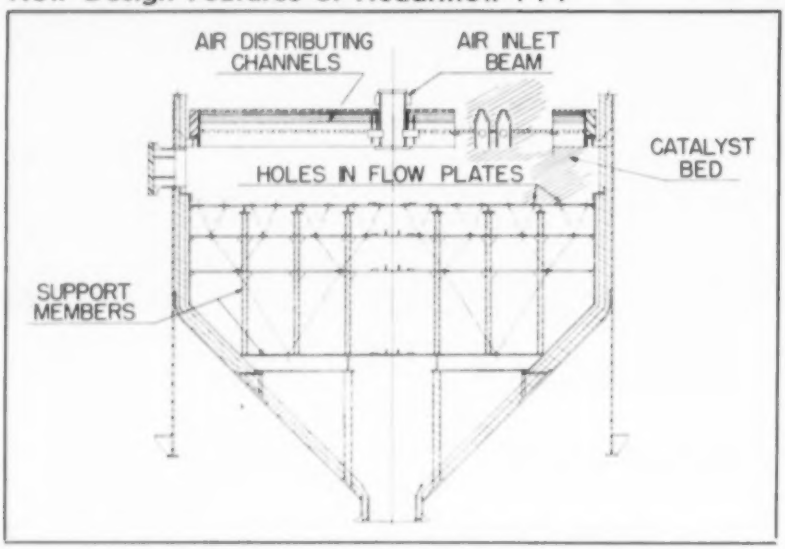


Figure 3. Kiln-air inlet and catalyst withdrawal section, type No. 1

produced in burning the catalyst coke deposit is carried by the catalyst from the kiln to the reactor. However, any excess heat must be removed from the catalyst stream. This is accomplished through steam generation cooling coils. Again good design principles require that all of the catalyst be uniformly cooled, and that this be accomplished with minimum disturbance to catalyst flow.

The catalyst mass must progress downward at a uniform flow rate over the entire area of the vessel so that every individual catalyst pellet has essentially the same residence time through both reaction and regeneration zones. Proper engineering is of particular importance in fulfilling this requirement.

The mechanical features utilized in Houdriflow units to accomplish these requirements of good moving bed design are discussed in the following sections. The developments in mechanical design are illustrated by comparing current Houdriflow with earlier moving bed designs.

Reactor Vapor Disengager

Oil charge stock is introduced to the reactor above the solid bed of flowing catalyst in the reaction zone. The hydrocarbon vapors flow concurrently with the catalyst through the bed to the level of the reactor vapor disengager. Here the vapors are separated from the catalyst and removed from the reactor for transfer to a distillation column wherein light hydrocarbon gases, catalytic gasoline and cracked gas oils are fractionated. High molecular weight hydrocarbons entrapped in the catalyst are also removed through the disengager by counter-current stripping with steam which is introduced below and flows upward to the disengager. Operating conditions at the disengager are about 875-900 F. and 6.0 psig.

In the reactors of earlier moving bed design, downwardly flowing hydrocarbon vapors and upwardly flowing stripping or purge steam are disengaged from the catalyst under a group of inverted V-shaped sections, herein identified as channels, and are removed from the reactor through a hollow rectangular beam. This arrangement is shown in Figure 1. Since the quantity of vapors which can be disengaged under a single level of channels is limited, additional capacity may be achieved by superimposed layers of channels connected to the main channels by vapor pipes.

The central beam penetrates and is welded to the reactor shell at one end, with the opposite end supported on a shell bracket. The collecting channels are slipped over nipples in the sidewalls of the beam and seated on brackets at the shell. Allowance is made for minor movement due to small differences in temperature between the shell and the internal parts. Although efforts are made in design to hold channels tight against the beam, working due to expansion sometimes creates a clearance sufficient for vapors to short cut the usual path and flow through the gap between the channel and beam. Catalyst fines are carried into the beam and are swept along with the vapors to the distillation tower where they settle out and require periodic cleaning.

Due to the nature of the design, it is difficult to obtain a good rigid construction. Reactor beds vary from 5 to 20 feet deep according to the process requirements and vertical loading on the disengager elements ranges between about 5 and 14 psi based upon gross cross sectional area of the reactor. The linear velocity of the catalyst is between 1.0 and 1.6 feet per minute. Not only the vertical loading but a certain degree of horizontal thrust is transmitted to the channels by the dynamic effect of the catalyst. Since the channels have to be free to expand they cannot be rigidly tied to prevent upsetting and precautions have to be taken by the installation of elaborate expensive guides, brackets, etc.

After several changes in design an arrangement was developed which is extremely rigid and does not have any of the disadvantages of the earlier design. Figure 2 presents the reactor vapor disengager now in use in the newest Houdriflow units. Hydrocarbon vapors and purge steam are disengaged from the bed under a battery of inverted V-shaped channels similar to the earlier design. In this arrangement the reactor shell is coned out to a diameter at the disengager level greater than the bed diameter. The lower portion of the reactor bed is contained in an inner skirt of the same

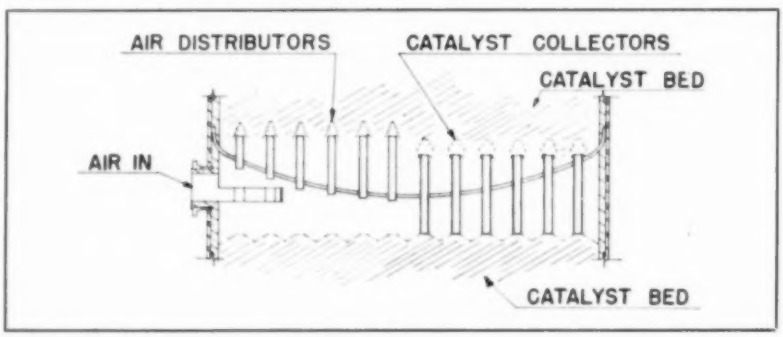


Figure 4. Kiln-air inlet upper zones

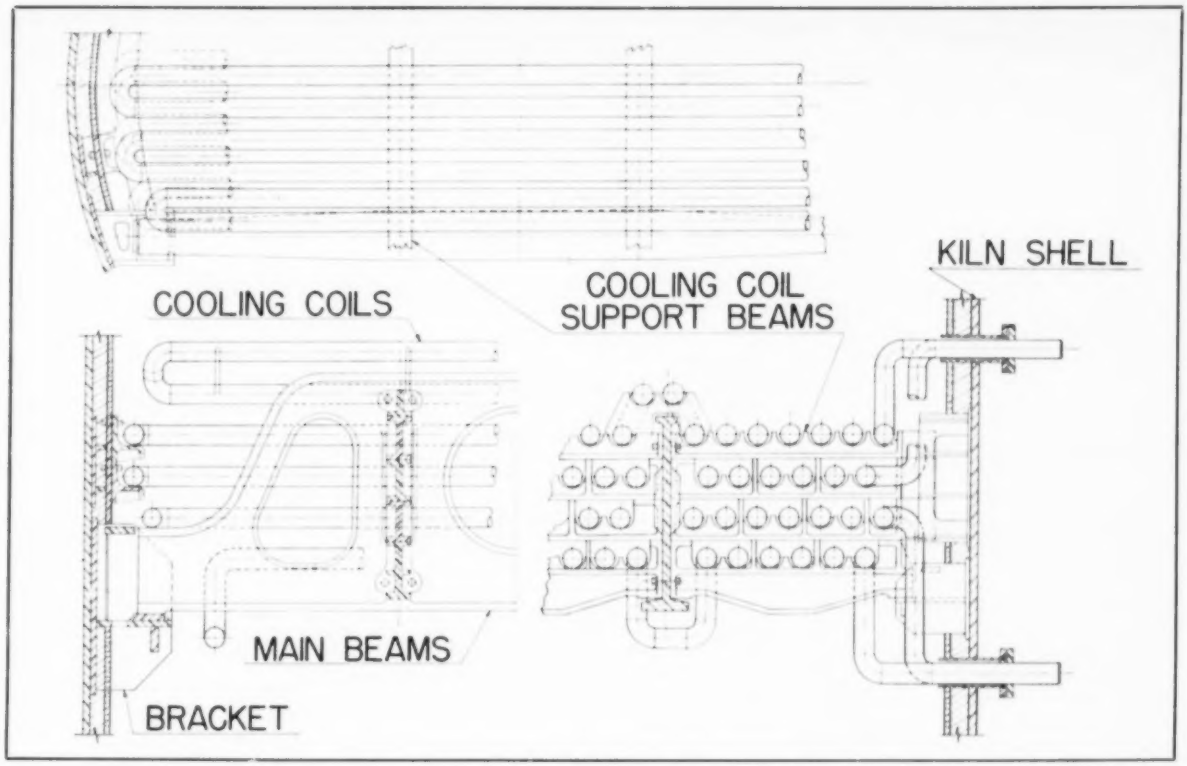


Figure 6. Kiln-shell contained cooling coils, type No. 2

diameter as the reactor shell above. It is welded in at the top of the cone and extends to support the channel sections. A completely rigid construction is achieved by welding the channels into the skirt. No expansion problem exists since vapors in the outer plenum assure uniform temperature for the skirt and channels.

Disengaged vapors flow out both ends of the channels and around the plenum to the reactor vapor outlet nozzle. The plenum volume is designed to keep the vapors below catalyst carrying velocity so that catalyst carry-over from the reactor into the outlet line is eliminated. Additional rows of channels supported on vapor pipes above the bottom channels can be used for increased capacity. These rows can be rigidly tied together also.

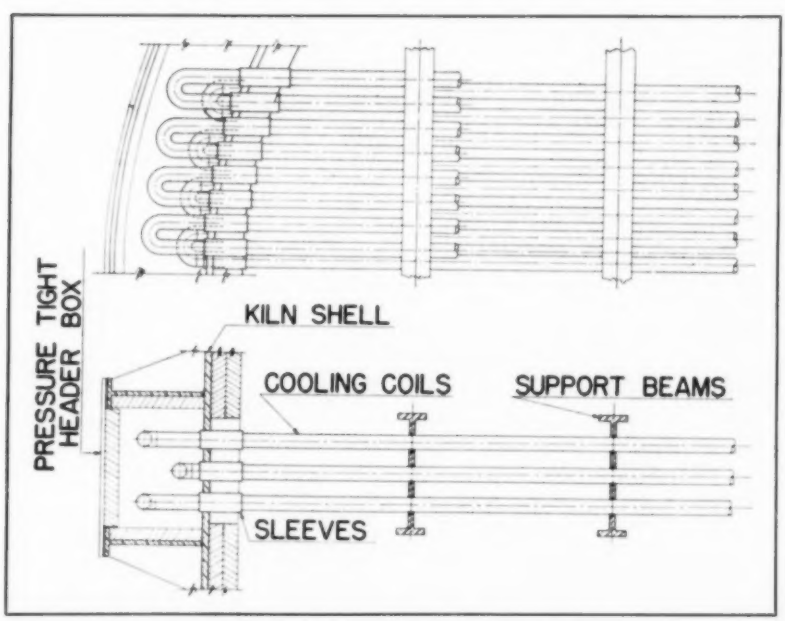


Figure 5. Kiln-shell piercing cooling coils, type No. 1

Kiln Air Distributor

While concurrent vapor and catalyst flow have proved best in reactor operation, the opposite is true in kilns. The minimum volume requirement for a given amount of coke regeneration with a specified quantity of air is achieved by using countercurrent flow of air and catalyst. Therefore good kiln design requires a scheme for uniformly distributing the regeneration air across the entire area of the catalyst bed by means of facilities which achieve maximum uniformity in catalyst flow through the vessel.

The upper portion of Figure 3 shows a channel and beam type construction of kiln air distributor used in the earlier moving bed units. It has aspects similar to the first reactor vapor disengager design of Figure 1. The catalyst withdrawal portion of Figure 3 will be discussed later.

Referring to Figure 3 air is piped into one end of a centrally located rectangular beam. The opposite end

New Design Features of Houdriflow . . .

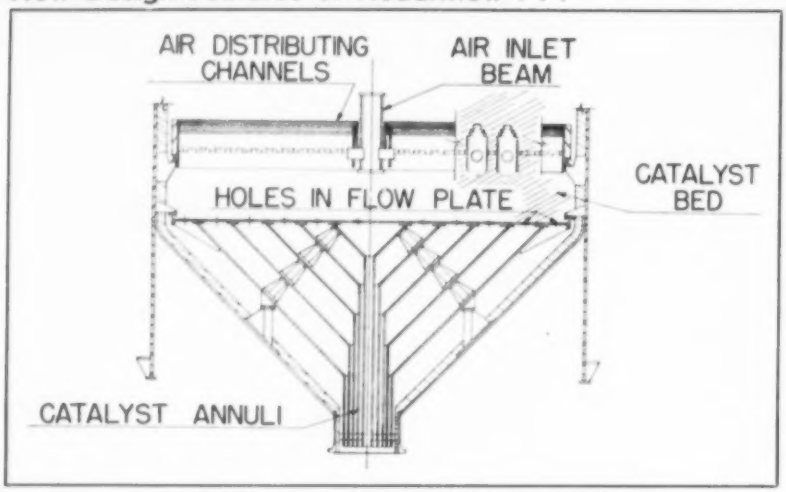


Figure 7. Kiln-air inlet and catalyst withdrawal section, type No. 2

is closed. The two ends of the beam project through and are supported in special rectangular nozzles in the kiln shell. Air passes from the beam into lateral distributing channels which are supported on nipples in the beam walls and on brackets at the shell. The catalyst flows downward through the narrow gaps between the channels. Although kiln internal insulation has generally given very little trouble, it appeared to be good insurance to provide a grating above the channels so that small spalled pieces of insulation would not plug the catalyst path. Several longitudinal louvres are provided in the sloping faces of the channels to allow air flow into the bed. This provision is necessary since the reduction in catalyst flow area at the channels is so much that the upward flow of the total quantity of air would stop the catalyst flow in the gaps between the channels.

While this air distributor design is being used satisfactorily there are inherent drawbacks. The beam must be free to take considerable expansion through the kiln shell, since the beam may operate at 1000 F, while the kiln shell is at less than 200 F. The rectangular cross section makes expansion joint design quite difficult and air leakage has been a problem.

As in the similar reactor design the contraction of catalyst flow area under a 15-foot bed into a number of parallel long narrow gaps results in considerable vertical and horizontal thrusts. Provisions against channel overturning are complex since rigid supporting of channels is impractical because of the necessary expansion allowance. The center beam with a flat top results in an area of catalyst stagnation which is undesirable. Variations in air velocity along the beam and across the channels and an indeterminant amount of catalyst plugging in the channel louvers creates some uncertainty about the uniformity of air distribution over the cross section of the kiln.

A decided improvement in kiln air distributor design employed in the latest Houdriflow units is shown in Figure 4. Catalyst is passed through the air engaging section by means of a number of pipes equally spaced in concentric circles in a dished head. Air pipes are located in the same circles alternating with the catalyst pipes. An adequate plenum is provided between the head and the catalyst bed below so that air can flow from the inlet nozzle to all the air pipes without disturbing the catalyst bed.

Each catalyst pipe is topped with a conical grating cap to prevent spalled pieces of insulation or any other debris from plugging the pipes. Each air pipe is covered with a cap having a number of circular louvers. Both of these caps are designed to be assembled from a few small castings so that their construction is cheap and simple.

The dished head gives one of the strongest types of construction possible. Due to its shape it naturally takes care of expansion differences resulting from the wide range of temperatures existing at this level. Temperatures vary from 1050 to 1150 F. for catalyst flowing through the pipes and from 200 to 1000 for the air. The kiln shell is approximately 200 F.

Both excellent air distribution in the catalyst bed and very uniform catalyst flow patterns are being achieved with this design, and low maintenance costs and long service are being experienced. Coupled with these performance advantages is the fact that the dished head design costs only about 65 percent of the cost of the beam and channel construction.

Kiln Cooling Coils

Since the cracking reactions are endothermic, heat must be supplied to the reactor. On the other hand, the combustion of coke liberates a considerable amount of heat which must be removed from the kiln. A large proportion of the heat of combustion is carried from the kiln by the catalyst which, in turn, supplies a portion of the reactor heat requirements. Sometimes it is possible to achieve a heat balanced design in which the portion of the heat of combustion removed from the kiln by the catalyst is equal to the heat requirement in the reactor. However, heat balanced design results in limitations on operating flexibility since changes in processing variables such as charge stock composition, oil charge rate, or cracking conversion level, upset the heat balance. Operating flexibility can be achieved by incorporating facilities for cooling the catalyst. Furthermore, use of cooling coils provides added protection against overheating the catalyst during combustion. For these reasons, Houdriflow kilns are equipped with catalyst cooling coils.

In kilns designed to burn 2000 pounds coke/hour or more, the carbon is burned off the catalyst in two or three steps since complete burning in a single zone would cause overheating of the catalyst with resultant loss in activity. The catalyst cooling coils are installed between the burning zones. Two types of cooling coils have been used, both of which have given excellent service.

The shell piercing type is shown in Figure 5 in plan and elevation. This design consists of a group of continuous horizontal coils, usually four or more. Adjacent horizontal runs are connected with welded return bends in external pressure-tight header boxes. The straight lengths of pipe are supported in sleeves through the kiln shell and internal insulation and by vertical beams reaching across the kiln and spaced so that stresses in the piping are kept at a low level.

The catalyst passes downward around the outside of the coils. The cooling is accomplished with water in a closed circuit. A pump takes suction from a steam drum and circulates the

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water through the coils at a high velocity. Effluent from the coils returns to the drum, where steam flashes off and is delivered to the refinery steam main. In other words, the design consists essentially of a water tube boiler, utilizing hot catalyst as the fuel. A dual objective is achieved, first, the catalyst is cooled to desired operating temperature and second, a valuable supply of steam is provided. Flash drum pressures vary from 150 to 600 psig according to the requirements of the different refineries.

One very important feature of this cooling coil design is that each coil is a single continuous series of pipes thereby providing equal cooling over the entire cross section of the kiln. The coils are externally manifolded with individual inlet and outlet valves. Irrespective of the number of coils in service all the catalyst receives equal cooling.

In operation the top row is always put in service first, with second, third and lower rows placed in operation as required. Thus the upper coils, which carry the load of catalyst and are exposed to the highest catalyst temperatures, have water circulating at all times so that the tubing is kept below scaling temperatures. Coils not in service are only exposed to the cooled catalyst.

A second coil design, identified as shell contained cooling coils, is shown in Figure 6 in plan and two elevation views. All of the process advantages of the first coil design are included in this arrangement. There are important mechanical differences, however.

The entire length of each coil, including return bends, is contained inside the kiln shell. Main beams traverse the kiln parallel to the coil piping and rest on shell brackets. Light weight short support beams are stacked between the main beams to carry the coils. The return bends rest on shell brackets. The design is arranged so that large sections of coil can be shop fabricated and only jumpovers around the main beams need be welded inside the kiln.

The choice between the two coil designs is subject to the preference of the refiner. The shell piercing type is somewhat more expensive in capital cost due to the shell openings and the large pressurized header boxes. It does allow for easy replacement of a single run of pipe in case a rupture occurs. The shell contained design requires considerable handling to get a leaking pipe, particularly if it is in a lower level. Actually the performance record for both designs is so good that no fair indication of differential maintenance requirements has been obtained.

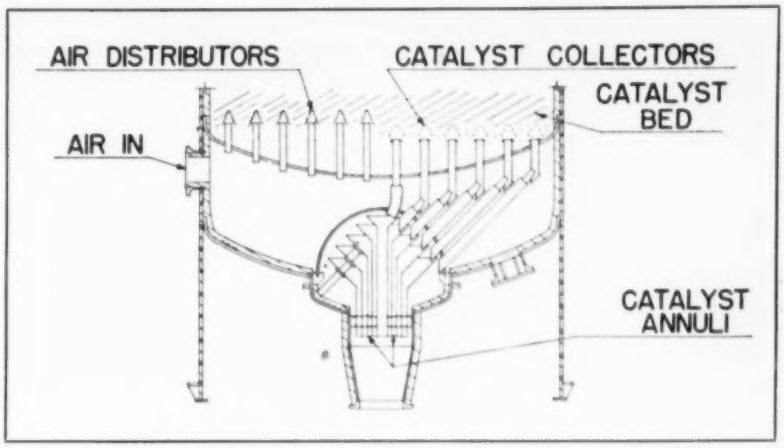

Figure 8. Kiln-air inlet and catalyst withdrawal section, type No. 3

Kiln Withdrawal Section

The provisions for withdrawing catalyst from the bottom of the kiln comprise one of the most important parts of the Houdriflow unit. The importance of uniform catalyst flow through the reactor and unequal burning rates in the kiln can result from poor flow at the withdrawal section of the kiln.

The catalyst withdrawal used in older moving bed units and in the first of the Houdriflow kilns is shown in the lower part of Figure 3. Four horizontal flow plates are situated at suitable vertical spacing. The bottom plate has a single circle of holes. The second plate up has two concentric circles of holes. The third plate has four circles and the top plate eight circles. The holes in the circles are closely spaced so that in effect each circle of holes approximates an annular opening in the flow plate. Thus the total catalyst flow in the kiln is first collected into eight streams, then in four, then two, and finally one annular stream which flows equally to the outlet nozzle.

The flow plates are supported one above the other by posts. These in turn are supported by the bottom cone which carries the dead load back into the kiln shell. Since considerable expansion allowance is necessary between the flow plates at 1100 F. and the kiln shell at 200° the plates can only be fastened with guide bolts. After a number of cycles of heating up and cooling down the plates may slide out of place so that the circles of holes are not properly aligned one to another and poor catalyst flow patterns may result.

A second design developed to give a more dependable method of catalyst collection is shown in Figure 7. This arrangement is in use under the same beam and channel air distributor as was shown in Figure 3. Catalyst feeds through concentric circles of holes in a flow plate into a group of concentric cones which in turn discharge through carefully spaced annuli. The percentage distribution of the area of the outlet nozzle between the several annuli is made equal to the percentage distribution of the kiln area carried in each cone thus assuring uniform flow velocity above the flow plate.

The concentric pipes are not nearly as sensitive to expansion difference as the stacked flow plate design, and considerable tolerance is permissible in situating the single plate. Therefore, this design definitely assures better catalyst flow patterns. Likewise it saves considerable verticle height over the multiple flow plate design.

With the development of the new Houdriflow air inlet system shown in Figure 4, a natural combination of that design with the principles of the concentric annuli drawoff was available. Figure 8 shows how the flow in each of the catalyst pipes through the dished head is directed into the group of cones. A small hemispherical head is used to position the discharge ends of the catalyst pipes.

This latest design reduced further the vertical height. Also, since catalyst may be flowing at temperatures up to 1100 F., alloy construction is usually employed, and this design reduces the material requirement and consequently the initial cost.

Original presentation of this material was before the Petroleum Division, American Society of Mechanical Engineers, Houston, September 28, 1953.

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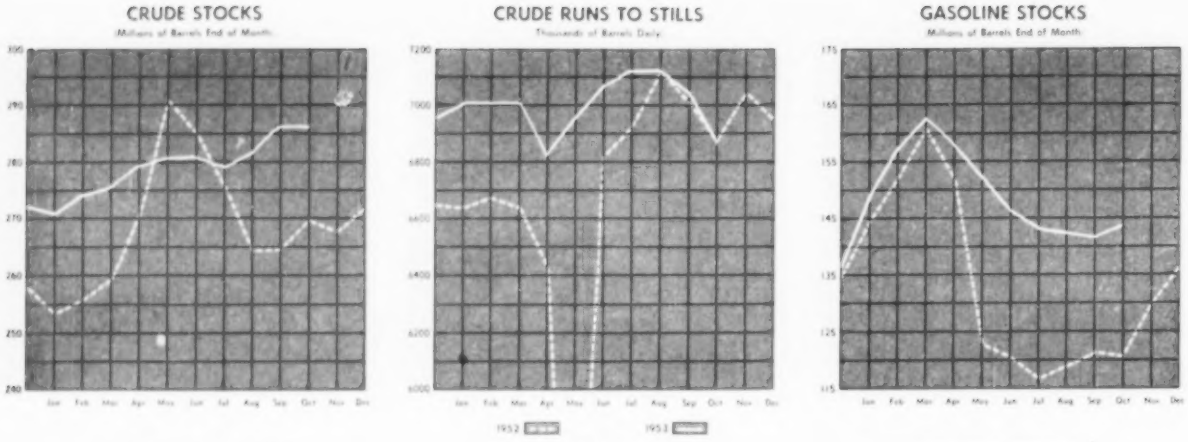
CRUDE STOCKS
Millions of Barrels End of Month
CRUDE RUNS TO STILLS
Thousands of Barrels Daily
GASOLINE STOCKS
Millions of Barrels End of Month
DISTILLATE FUEL STOCKS
Millions of Barrels End of Month
RESIDUAL FUEL STOCKS
Millions of Barrels End of Month
KEROSINE STOCKS
Millions of Barrels End of Month

Taking Stock

Cecil W. Smith
Economics Editor

(DATA IN THOUSANDS OF BARRELS)

MONTH	CRUDE OIL			GASOLINE		KEROSINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1952:													
April	6,459	6,435	270,679	2,995	151,880	366	18,955	1,312	51,634	1,253	38,561	539	922
May	5,107	4,905	290,813	2,295	123,656	229	19,614	982	51,648	979	38,821	545	951
June	6,197	6,825	285,964	3,169	120,166	317	23,061	1,455	65,911	1,228	45,688	581	901
July	6,080	6,927	273,951	3,295	116,366	358	27,387	1,475	85,775	1,247	52,245	597	892
August	6,219	7,118	264,368	3,377	118,502	375	32,401	1,514	104,257	1,252	54,961	632	879
September	6,518	7,017	264,725	3,428	120,991	350	35,021	1,502	117,252	1,230	56,200	615	932
October	6,518	6,883	269,776	3,301	120,062	352	33,289	1,458	120,721	1,203	53,052	643	1,038
November	6,487	7,049	267,852	3,416	129,509	393	32,199	1,510	116,086	1,299	53,069	624	984
December	6,634	6,952	271,928	3,361	136,028	421	26,842	1,509	99,582	1,302	48,706	603	1,165
1953:													
January	6,555	7,042	272,250	3,384	150,518	433	23,292	1,528	80,655	1,307	45,910	616	1,135
February	6,502	6,969	273,589	3,379	157,873	404	20,468	1,505	67,167	1,275	44,178	586	1,066
March	6,531	7,002	275,665	3,319	162,731	359	18,697	1,489	59,802	1,256	41,600	655	1,112
April	6,446	6,781	280,487	3,282	158,032	361	20,335	1,424	61,349	1,219	39,572	628	1,010
May	6,390	7,002	280,308	3,366	156,415	327	24,307	1,400	73,706	1,197	41,795	703	1,096
June	6,505	7,081	283,715	3,467	146,196	326	27,659	1,462	84,504	1,238	43,801	707	1,050
July	6,603	7,103	284,976	3,583	143,916	321	31,143	1,441	102,258	1,224	47,530	629	950
August	6,583	7,163	285,352	3,592	146,050	321	35,711	1,437	119,542	1,222	50,007	672	946
September	6,495	7,044	286,431	3,497	142,906	327	37,116	1,430	126,694	1,222	51,922	672	1,015
October	6,240	6,878	286,401	3,417	143,368	366	37,963	1,452	134,631	1,175	51,558	659	1,010
Oct. 1953 Change:													
In Month	—255	—166	—30	—80	+462	+39	+847	+22	+7,937	—47	—364	—13	—5
In Year	—278	—5	+16,625	+116	+23,306	—14	+4,674	—6	+13,910	—28	—1,494	+16	—27
Week Ended:													
11-14-53	6,219	6,951	284,932	3,506	144,954	338	36,779	1,435	133,983	1,143	51,696	775	1,290
11-15-52	6,622	7,096	266,662	3,425	123,313	353	32,247	1,556	119,148	1,236	51,942	752	1,100

Source: Data for last two months from API; prior monthly data from Bureau of Mines.

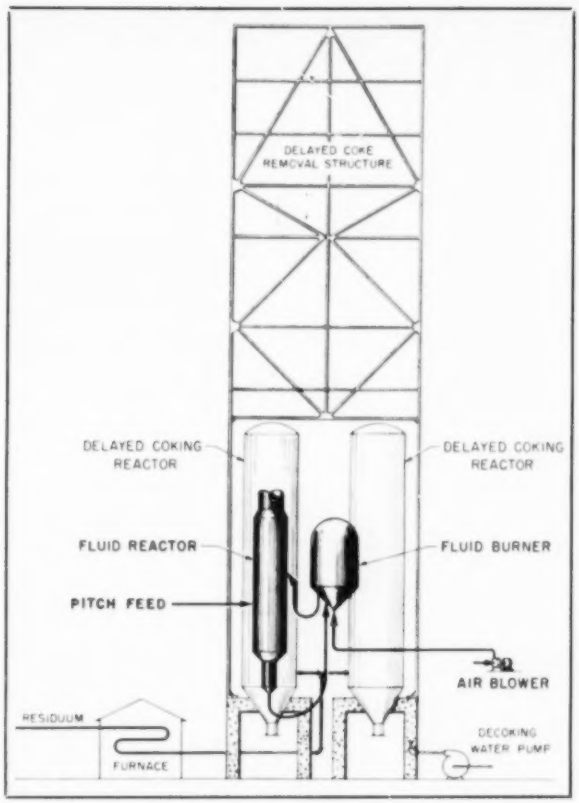

Figure 1. Fluid coking compared with delayed coking.

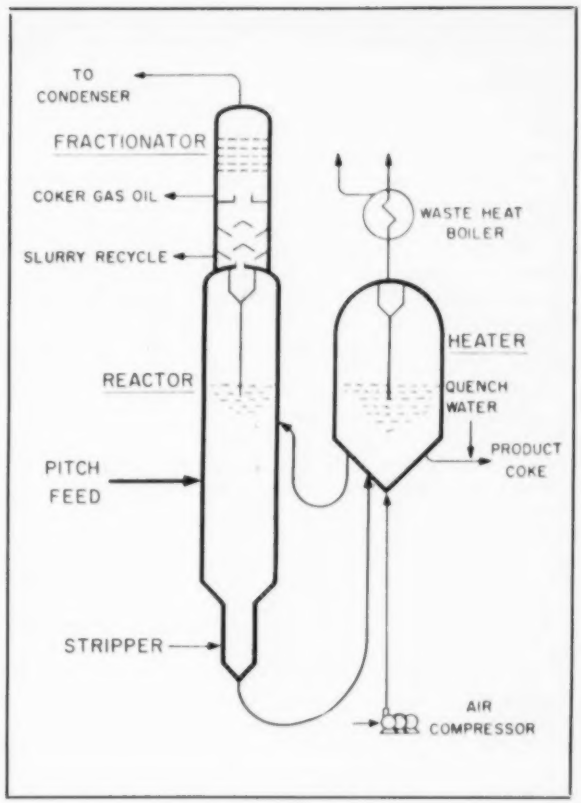

Figure 2. Fluid coking unit.

New Fluid Coking Process Unveiled

The most recent process contribution to the solution of the fuel oil problem is Esso's new fluid coking process. Detailed below are important data on operating conditions, yields, and design factors.

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H. Z. Martin, Standard Oil Development Company, Linden, N. J.

THE ESSO Laboratories at Linden, N. J., and at Baton Rouge, La., have developed during the past few years a new coking process which has been named "fluid coking." Basically, this process is an adaptation of the fluidized-solids technique to the coking of crude residua and similar low-grade oils. The fluid coking process employs no catalyst; it depends on a circulating stream of finely divided coke particles to furnish the heat necessary to accomplish the coking reaction. By virtue of the small size of the coke particles, the available surface for heating is very large.

Incentive

During recent years there has been considerable incentive for upgrading residua because of the spread in price between crude and fuel oil. Only during the period 1946-48 did fuel oil prices equal those of crude. The demand for heavy fuel oil relative to lighter petroleum products has been steadily decreasing with the years. Therefore, refiners have been seeking economical methods for reducing fuel oil production based on vacuum distillation, de-asphalting, and coking.

Vacuum distillation has found extensive use in maximizing the production of catalytic cracking feed stocks, although the extent to which crude can be reduced by this means is dependent on crude quality. Therefore, the quantity of the resulting residuum may vary from as little as approximately 4 percent for such crudes as South Louisiana to 40 to 50 percent for some of the heavier crudes which are now coming into the picture. The chief limitations to an increase in the amount

of gas oil taken overhead in vacuum distillation are: (1) the tendency of the high-boiling components to crack to excessive quantities of gas; and (2) the carry-over of traces of metals which contaminate cracking catalysts. As the percentage overhead obtained by vacuum distillation of a metal-containing reduced crude is increased, the concentration of metal in the distillate increases in a regular manner.[1] Therefore, flash cut points are usually held at about 1000 to 1050 F.

Propane de-asphalting is similar to distillation in that separation of asphalt, color bodies, and other undesirable constituents from reduced crudes is effected primarily according to molecular weight. Although the bulk of the metal-containing components is rejected in the higher-molecular-weight asphaltic fractions, varying proportions of the lower-molecular-weight metal-containing compounds are retained in the de-asphalted oil. The application of de-asphalting has been mainly for lubricating-oil production, and there are only three units in the U. S. and one unit outside this country which are operating for production of cracking feed stock.

Various Coking Processes

Coking has been known since the earliest thermal cracking of petroleum in batch shell stills. Coking at that time was both a nuisance and a safety problem; coke removal was effected by hand labor. When coil cracking of petroleum began to replace shell-still cracking about 1920, coke accumulated in the reaction chambers in troublesome quantities, and this resulted in runs of short duration and frequent shutdowns for cleaning. Systematic attempts made in the mid-'30's to convert cracked residuum to coke in order to minimize fuel oil production resulted in the first version of what we now know as the delayed coking process.[2] Basically, this process employs a reaction or coking chamber, designed so as to accumulate substantial quantities of coke between cleanings. Of the numerous devices which have been employed to effect coke removal, the hydraulic decoking operation has afforded a reasonably attractive solution. However, the delayed coking process is essentially a batchwise process. Two vertical coke drums are generally employed, one of which is being decoked while the other is onstream. The labor and utilities associated with the decoking operations are a definite debit to the process. Moreover, the coking vessels represent a very considerable volume not only because duplicate vessels are needed, but also because a relatively long reaction time is required to complete the coking reaction.

Although refiners have known for a long time how to produce coke, the successful operation of a coking process is more directly dependent on the method of decoking. It has always appeared desirable to decoke continuously, but the first process which employed this feature was not announced in the literature until 1949, when the continuous contact process was disclosed.[3]

The recent announcement[4] by Standard Oil Development Company of the availability of the fluid coking process for licensing now makes available to the industry another truly continuous process. No periodic shutdowns for removal of coke are required, and the reactor can be maintained continuously at the desired operating conditions. The single reaction vessel required is considerably smaller than for delayed coking. As an illustration, Figure 1 shows a comparison of plant sizes for delayed and fluid coking units of the same feed-charge capacity. Estimates indicate that the process will be lower in investment and operating costs than are the older coking methods.

History of Fluid Coking Development

Standard Oil Development Company has an extensive background in the development of petroleum processing operations which employ fluidized-solids techniques. Work on fluid catalytic cracking started well before World War II, when a process was particularly needed to meet the increased demands for motor gasoline of higher octane number. The first commercial plant was placed in operation at the Baton Rouge refinery in May, 1942. The well-established principles of fluid-solids operations which resulted from this catalytic cracking development have since been applied to fluid hydroforming, and now to fluid coking. Other applications of the fluid-solids technique are: the preparation of phthalic anhydride, the calcination of limestone, the manufacture of activated carbon, and the roasting of pyrites.

Experimental studies on fluid coking were started several years ago in a small, continuous fluid-solids pilot unit. These prelimary tests served to show the possibilities of the process and pointed out the fields for research and development. Next, a systematic study of the process was conducted in a unique "bench-scale" pilot plant with interchangeable reactors heated in a fluidized sand bath. Here it was established that favorable yields could be obtained from even the heaviest pitches, and that temperatures in the range of 850 F. to 1050 F. were well-suited for catalytic cracking feed-stock production. However, these small units were batch fluid units. Larger equipment was needed to demonstrate continuous fluid coking, and attention was turned to a 100-barrel-per-day pilot plant.

Ideally suited for this study was the original 100-barrel-per-day fluid catalytic cracking pilot plant, built at Baton Rouge in 1940, and used since then for several projects, including fluid retorting of oil shale and demonstration of the Model IV fluid cracking unit design. With a few essential modifications, the plant was converted from a Model IV catalytic cracker into a coking plant. Of course, the entire feed-introduction system was new in order to permit direct injection of pitch into the reactor. Only sufficient heating of the pitch feed is required to lower its viscosity for easy handling.

Process Features

A schematic flow plan of the elements of a fluid coker is shown in Figure 2. It will be observed that the unit consists basically of a reaction vessel and a burner vessel. Operating pressures are substantially atmospheric, but may be higher if desired. The residuum feed is preheated and then is injected into a bed of hot fluidized coke particles which are formed in the process. These spheroidal coke particles are small in size, although generally somewhat coarser than fluid cracking catalyst, and thus provide a large amount of surface per cubic foot of fluidized material. This large surface serves the multiple functions of: (1) retaining the pitch during conversion; (2) aiding in the evaporation of products; and, (3) providing an area for coke deposition.

The basic function of the fluid coke is that of a heat carrier. Rapid heat transfer is obtained by virtue of the fine particle size of the fluid coke. As the feed is injected into the reactor, it is, therefore, heated up very quickly. At reactor temperatures the viscosity of the residuum is low so that its distribution over the surface of the fluidized solids is rapid and uniform. In the reaction zone the heavier fractions of the feed stock are only partly vaporized, most of the cracking reaction being effected in the liquid phase. However, the more volatile products are rapidly evaporated from the surface of the coke so that the products

consist of a dry overhead vapor and dry coke. Excellent mixing takes place in the fluid bed, and this gives virtually isothermal conditions in the reactor, just as is the case in fluid catalytic cracking.

The vapor products from the fluid bed are taken overhead through a cyclone separator located in the upper end of the reaction vessel. Most of the entrained solids are separated at this point and returned to the fluid bed. The overhead product, with a small amount of coke dust, is then passed to fairly conventional refining equipment. Some recycle bottoms are returned to the reactor in order to carry back the small amount of coke which has escaped through the cyclone and to permit recracking of the bottoms into the gas oil boiling range.

The heat for carrying out the coking process is generated in the burner vessel. The fluidized coke from the reactor, which has been steam-stripped in the bottom of the reactor, is transferred to the burner by a standpipe riser system. Air is supplied to the bottom of the burner, and only enough coke is burned to maintain the system in heat balance. For example, the temperature in the fluid-bed burner may be maintained in the range of 1100 to 1200 F. In a typical installation the amount of coke burned is equivalent to 4 to 5 percent by weight on feed. If desired, extraneous fuels may be substituted for the coke burned. The heat from the burner vessel is transferred to the reactor by the maintenance of a flow of solids between the two vessels.

TABLE 1
100-Barrel-Per-Day Fluid Coking Plant—Once-through Operations on Three Vacuum Residua

Feed-Stock Source:	South Louisiana Mixture	Elk Basin	Hawkins Batch 1
Feed Inspections:			
Gravity, deg. API	13.2	2.5	4.5
Conradson carbon, percent by weight	14.0	30	23.2
Ash, percent by weight	0.23	0.11	0.07
Sulfur, percent by weight	0.9	3.5	4.5
Viscosity (Saybolt Furol)			
at 275 F, sec.	18	393	342
5-percent point, F	Cracks	1,000	902
Correlated Yields on First Pass:			
C_5 to 430F FVT* naphtha, percent by volume	12.5	12	15
430 to 1,015F FVT gas oil, percent by volume	42.5	29	36.5
1,015+ F bottoms, percent by volume	35	35	27
C_4, percent by volume	2	2	2.5
C_3 and lighter gas, percent by weight	6.5	6.5	7
Coke, percent by weight	8	23	19
Product Quality:			
C_5 to 430 F: gravity, °API	52.5	52	53
C_5 to 430 F: sulfur, percent by weight	0.1	0.3	0.7
C_5 to 430 F: research octane No. without TEL addition	78.5	78.5	78.0
Gas oil: gravity, °API	23.5	19	16.5
Gas oil: sulfur, percent by wt.	0.4	2.8	3.7
Gas oil: Conradson carbon, percent by weight	1.4	2.4	2.1
Bottoms: gravity, °API	13	0.7	1.0
Bottoms: Conradson carbon, percent by weight	14	30	26

* FVT = final vapor temperature.

Figure 3. Photomicrograph of fluid coke.

Because only a part of the coke deposited is burned to supply heat, the coke particles grow in size during the process. In order to counteract the growth process and to maintain a constant particle-size coke inventory, fine coke must be added continuously to serve as growth "seeds." The seeds required can be supplied either by grinding withdrawn coke in external equipment or by devices in the unit itself. However, because the seed coke is much smaller in diameter than the average of the withdrawn coke, the weight of seed required is only a small percentage of the weight of coke withdrawn.

As can readily be visualized, the process is flexible in the range of permissible operating conditions. For example, higher or lower temperatures may be employed. Also, there is considerable flexibility in the choice of particle size of the circulating fluid coke. However, this circulating coke generally is somewhat coarser than the normal fluid cracking catalyst, which is largely material through 100-mesh.

The fluid coking process is completely continuous, and operates just as simply as fluid catalytic cracking. But, aside from the continuous nature of fluid coking, the process possesses some other advantages over conventional delayed coking. No preheat furnace is required. Residua are normally available at 500 to 700 F., and this temperature is adequate for good feed dispersion. Thus, the furnace-coking problem is not a factor in the process. There appears to be no feed limitation if the stock can be handled in pumps and pipes. Fluid coking pilot plants have been operated on feeds which vary in boiling range from whole crudes to residua having close to a 1200 F. initial boiling point.

100-Barrel-Per-Day Plant Demonstration

The 100-barrel-per-day fluid coking unit at Baton Rouge has been in operation for more than a year. Because the yield structure from the fluid coking process already had been determined in small-scale laboratory equipment, the primary purposes of operating the 100-barrel-per-day plant were to get a convincing demonstration of the operability of the process and to get engineering data for large plant design. The operation of a pilot plant on the scale of the 100-barrel-per-day unit gives an excellent test of the operability of a new process. During the operation of the 100-barrel-per-day unit the problems associated with continuous operation on a large scale have been systematically worked out, and operating techniques have been continually improved and perfected. The year of experience in the operation of the 100-barrel-per-day plant has clearly demonstrated the fundamental practicability of the fluid coking process. The circulating coke system has operated exceedingly well, and problems which arose in connection with the auxiliary equipment have been successfully met.

One problem was to find the best way to distribute the pitch into the fluid coke bed in the reactor so as to get optimum distribution of feed. As a result, a very satisfactory feed-injection system was developed and successfully demonstrated. Another problem which had been anticipated was associated with a tendency to form coke in overhead equipment. This is a common phenomenon when heavy ends are processed at high temperatures. However, the fluid coking process inherently minimizes this problem, and a very successful solution was worked out. For example, a recent run in the 100-barrel-per-day unit was terminated voluntarily after more than 500 hours at design conditions without any pressure drop in the overhead lines up to the point where quench oil is normally introduced in commercial equipment.

Typical Yields

Typical fluid coking yields from operations in the 100-barrel-per-day plant on three feed stocks are shown in Table 1. The feeds are all vacuum bot-

toms. The South Louisiana mixture is a light sweet blend, predominantly South Louisiana crude, whereas Elk Basin and Hawkins are much heavier sour crudes. These large pilot-plant data are for "once-through" operation, but most commercial plants would be run with recycle to 100-percent conversion of the material boiling above the gas oil. In the examples shown in Table 1, this gas oil was cut at a 1015 F. still vapor temperature, and this produced a feed suitable for catalytic cracking. However, it is not implied that 1015 F. is necessarily the optimum cut point. This point will depend upon the feed stock and the operating conditions. Also, it should be emphasized that the 100-barrel-per-day plant was run primarily to obtain operating and engineering data; and, hence, the yields shown in Table 1 are not optimum.

The coker naphthas from the three feeds shown in Table 1 are quite similar except for sulfur content, and that value varies with the feed stock. Unlike the relatively uniform quality of the gasoline, the quality of the coker gas oil is considerably affected by the character of the coker charge stock. In Table 1 it can be seen that the higher grade South Louisiana residuum gave a higher API gravity and lower Conradson-carbon gas oil than the heavier Elk Basin and Hawkins feeds. Of course, the coker bottoms follow the same trends. In general, the quality of the coker bottoms is not far from that of the residuum feed.

In order to estimate ultimate yields with bottoms recycle to extinction, successive pass coking has been conducted in the laboratory pilot plants on the 1015 + F. bottoms from once-through coking. From these data ultimate yields for favorable coking conditions have been calculated for two feeds, and are shown in Table 2. The residuum was converted from fuel value to 76 to 85 percent by volume of gasoline and gas oil and 24 to 36 percent by weight of fuel products. It will be noted that the coke yields are close to the Conradson carbon of the original feed. This is typical of the data on a wide variety of feeds, and is another way in which fluid coking differs from delayed coking. In the latter process coke yields are closer to twice the feed Conradson carbon.

TABLE 2

Estimated Ultimate Yields from Fluid Coking of Two Vacuum Residua

Feed-Stock Source:	South Louisiana Mixture	Hawkins Batch 2
Feed Inspections:		
Gravity, °API	13.2	4.0
Conradson carbon, percent by weight	14	24
Ash, percent by weight	0.23	0.07
Sulfur, percent by weight	0.9	4.5
Ultimate Yields, Percent on Feed:		
C₄ to 430 F FVT* naphtha, percent by volume	21	21
430 F to 1015 F FVT gas oil, percent by volume	61	52
1015+ F bottoms, percent by vol	0	0
C₄, percent by volume	3	3
C₃ and lighter gas, percent by wt	8	9
Coke (total), percent by weight	16	27
430 to 1015 F. FVT Quality:		
Gravity, °API	23	17
50-percent point, F.	750	800

* FVT = final vapor temperature

Properties of Fluid Coke

The coke produced in fluid coking has some interesting and unique properties. Its fine, but uniform, particle size makes it easily handled as a fluid but, nevertheless, it is a clean, dustless solid. The roundness of the particles, (as seen in photomicrograph, Figure 3) is a property which may make possible some unique applications. Chemical and physical properties are given in Table 3. The low hydrogen and volatile matter in the coke are an indication of the calcination which takes place in the burner vessel. The coke is expected to find its way into the already established markets for petroleum coke; e.g., as fuel, for electrodes, and for other products. Studies are being made on the use of fluid coke as raw material for the manufacture of electrodes for the aluminum industry. The transportation of fluid coke can be adequately handled by pipe lines, gondola railway cars, barges, and other carriers.

Cracking of Coker Gas Oil

For the recycle coking operation, the yields shown in Table 2 are based on the production of a 430 F. to 1015 F. gas oil for subsequent catalytic cracking. As already pointed out, the choice of the 1015 F. cut point is somewhat arbitrary. The optimum end point may be higher or lower depending on the composition of the original residuum with respect to metals—nickel, vanadium, iron—which are undesirable contaminants of cracking catalysts. Of course, a similar situation exists in the primary distillation of the crude in vacuum towers to produce a high end-point virgin gas oil for catalytic cracking. In this primary vacuum distillation, as in fluid coking, trace quantities of very high-boiling volatile metal compounds—nickel, vanadium, iron—are taken overhead when high end-point gas oils are produced, and the quantity of such trace catalyst poisons depends both on the cut point and on the composition of the crude. In the preparation of feed stocks for catalytic cracking it is generally economical to go to the highest end point of gas oil consistent with tolerable quantities of these catalyst contaminants.

However, in many refinery situations, especially when catalytic cracking equipment is not available, the opportunity exists for a very simple combination of fluid coking and thermal cracking. In this case the fluid coking is conducted once-through—which somewhat shrinks the size of the coking unit—and the total coker overhead minus the gasoline fraction may be fed directly to a thermal cracking unit.

Commercial Application

Standard Oil Development Company is making the process available to the industry under license at reasonable royalty rates. As already announced, affiliates of Standard Oil Company (New Jersey) have plans for building three fluid cokers in the United States. The first commercial installation, which is already in the design stage, is for the Billings, Mont., refinery of The Carter Oil Company. This is a 3300-barrel-per-day unit, and is scheduled for initial operation in late 1954. Esso Standard Oil Company plans to follow about a year later with a 10,000-barrel fluid coker at Baltimore and a 21,000-barrel unit at Baton Rouge.

Original presentation of this material was before the 33rd annual meeting, American Petroleum Institute, Chicago, November 9, 1953.

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[2] J. H. Eppard, W. F. Sims, and F. D. Parker, "Reducing Fuel Oil by Residuum Coking," *Petroleum Refiner* **32**, [7] 99, (1953).

[3] A. H. Schutte and W. C. Offutt, "Continuous Contact Coking Process," *Oil Gas J.* **48** [10] 90, (1949).

[4] *New York Times* and *New York Herald-Tribune*, New York, N. Y., Aug. 11 (1953).

TABLE 3

Quality of Product Coke from 100-Barrel-Per-Day Fluid Coking Pilot Plant

Vacuum Residuum Crude Source:	South Louisiana (Partly Desalted)	Elk Basin	Hawkins
Coke:			
Carbon, percent by weight	92.5	88.6	88.3
Hydrogen, percent by weight	1.6	1.8	1.9
Sulfur,* percent by weight	1.4	6.4	7.0
Volatile Matter, percent by Weight:			
At 1100 F.	0.6	1.3	0.9
At 1742 F. (950 C.)	—	5.3	5.0
Ash* (percent by weight) at 1100 F.	2.8	0.7	0.7
Ash Components, as Metal in Coke:			
Vanadium, percent by wt.	0.01	0.17	0.02
Nickel, percent by weight	0.01	0.06	0.01
Iron, percent by weight	0.11	0.08	0.04

* Values for ash and sulfur are higher than will be obtained commercially for these 2 reasons: 1, a greater percentage of the coke make is burned in the pilot plant than is anticipated for commercial operation: and, 2. the bottoms recycled commercially will have a lower ash-to-coke ratio than the portion of the feed converted in the 1-pass pilot-plant operation.

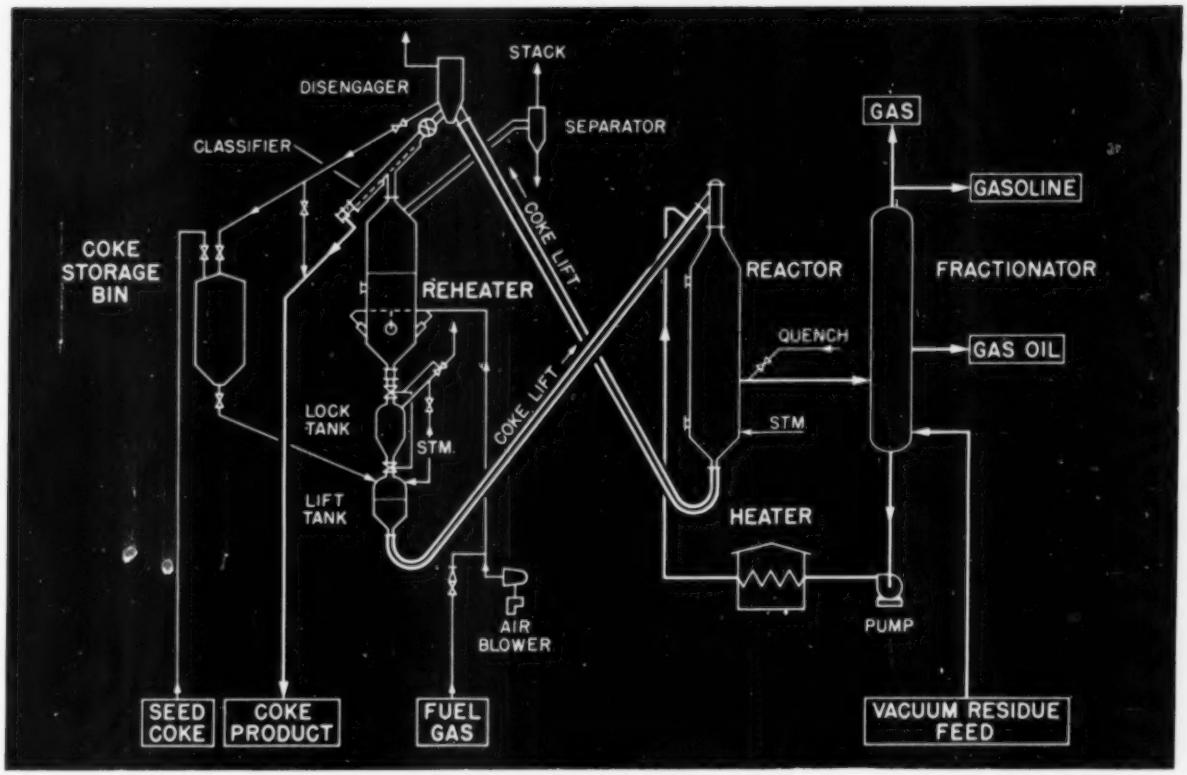

Figure 1. Flow diagram of 1000-barrel-per-day contact coking unit

A performance report . . .

The Lummus Continuous Contact Coking Process

Designed to convert low value residua into more useful middle distillates, the first installation of the new process claims these advantages

- **Continuous rather than batch operation**
- **Higher octane gasoline**
- **High yield of olefins**

Valentine Mekler, A. H. Schutte and T. T. Whipple, The Lummus Company, New York

THIS IS ESSENTIALLY a report on the performance of the first commercial continuous contact coking unit, erected in the McKee refinery of The Shamrock Oil and Gas Corporation, Sunray, Texas. It was designed to process vacuum-distillation residue from Panhandle crude oil—at a nominal charge rate of 1000 barrels per day—for the production of gas, gasoline, gas oil for catalytic cracking feed, and coke. The unit has been in operation for the past eight months, during which period yields over a wide range of operating conditions were obtained. The outstanding feature of the unit is its flexibility and ability to handle feed stocks much heavier than normally can be processed by conventional delayed coking.

Data on yields, product specifications, and operating costs are presented in this article.

History of Development

The development work on the continuous contact coking process has been carried out during the past six years, and was described in earlier

MAINTENANCE / OPERATION

Lummus Continuous Contact Coking . . .

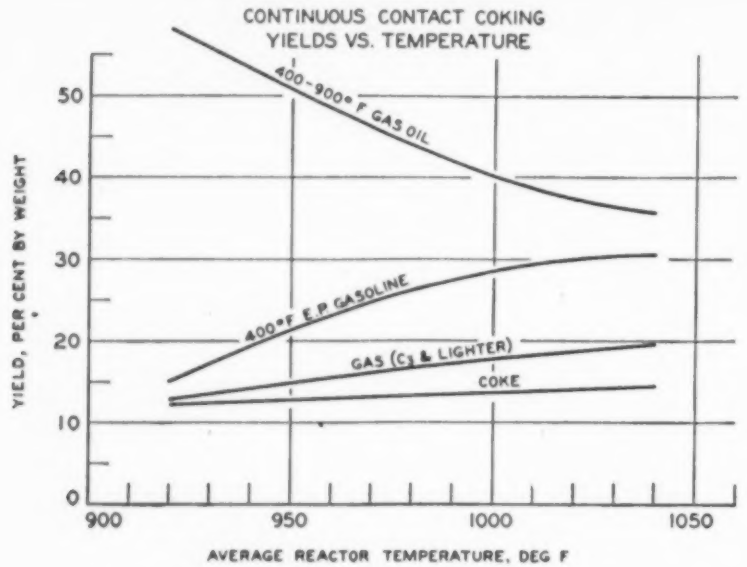

Figure 2. Correlations of product yields vs. reactor temperature

publications.[1, 2, 3a] This work was accomplished with: (1) a laboratory unit; (2) a 50-barrel-per-day pilot unit, followed by; (3) a 100-barrel-per-day semi-commercial unit; and, finally, (4) the commercial unit described in this paper. Yield correlations between the laboratory unit and the commercial unit have been established. The laboratory unit now is used to evaluate any stock with reasonable confidence.

Description of Unit

Figure 1 is a simplified flow diagram of the 1000-barrel-per-day unit.

The unit consists essentially of: (1) a reactor in which the oil-wetted coke particles or "seed" coke flow downward as a dense bed; sufficient time is provided in the reactor for the cracking, coking, and drying reactions; (2) a reheater in which the circulating coke is raised in temperature to supply the heat of reaction, some sensible heat to the feed, and radiation losses; (3) a coke-circulating system which uses the "mass-flow" principle to elevate the coke as a dense unagitated column; and, (4) a fractionation system for the separation of products.

The vacuum-residue feed is introduced into the bottom of the fractionator, where it is mixed with recycle stock and further preheated in a tubular heater to approximately 700 F. This feed is mixed thoroughly with the hot circulating coke stream. The lighter portions of the feed are vaporized, and the heavier constituents are retained on the coke particles as a liquid film. As the coking reaction proceeds, the film is converted into gas, hydrocarbon vapors, and residual coke, and the latter is retained on the seed particle. As successive increments of coke are deposited, a gradual increase in coke-particle size occurs. The larger particles, which have a diameter of approximately one-half inch or more, are drawn off continuously as product coke to maintain a nearly constant coke inventory in the system. The vapors from the reactor, at a temperature of 900 to 1000 F., are quenched and released to the fractionator. From the bottom of the reactor the dried coke is elevated to the disengager by a low-pressure mass lift which is "powered" by the reactor pressure of 35 psig. The coke from the disengager flows by gravity into the reheater, where it is heated to between 1000 and 1100 F. by gas-firing or by burning a portion of the coke. The reheated coke is discharged intermittently by gravity into the lock tank, from which it flows into the lift tank to start another cycle of the coke circuit. The energy for circulating the coke is supplied by 150-psig steam at the lift tank. The sequence of coke flow from the reheater and lock tank is controlled automatically by a cycle timer.

This is the first commercial installation of the "mass-flow lift" developed by Union Oil Company of California. The coke circulation is continuous and smooth. The rate of flow is controlled by a rotary star valve above the reheater. Only one coke level must be controlled—that of the reheater. The coke-circulation rate may be increased or decreased by varying the speed of the rotary star value.

The ratio of oil to coke for normal operation is 10 barrels of oil per day per ton of coke circulation per hour, i.e., 1 pound of oil per 14 pounds of coke circulated.

The highest elevation of any equipment is 80 feet above grade. The reactor and reheater are supported from

TABLE 1
Properties of Charge Stock, Yields, and Product Specifications

	Texas Panhandle Vacuum Bottoms
Charging Stock:	
Gravity, °API	18.9
Material boiling at lower than 950 F., percent by volume	2.0
Sulfur, percent by weight	0.6
Conradson carbon, percent by weight	11.7
Viscosity (Saybolt Furol) at 122 F., sec.	1,227
Characterization factor, UOP	12.3
Percent on crude	10.0
Operating Conditions:	
Oil inlet temperature, F.	690
Coke inlet temperature, F.	990
Coke outlet temperature, F.	915
Average reactor temperature, F.	955
Reactor pressure, psig	36
Mass Lift:	
Coke circulation, tons per hour	75
Lift-tank pressure, psig	130
Lift steam, lb. per hour	650
Yields, Percent by Weight:	
C_3 and lighter	14.5
C_4 to 400-F. gasoline	22.0
Gas oil	51.0
Coke	12.5
	100.0
Inventory Coke—Screen Analysis:	
Percent by weight retained on screen (Tyler):	
Tyler Screen No.:	
0.25-in. mesh	49.0
0.187-in. mesh (4)	21.4
0.131-in. mesh (6)	13.8
0.096-in. mesh (8)	12.6
0.065-in. mesh (12)	1.8
0.039-in. mesh (18)	0.9
Pan	0.5
PRODUCT INSPECTION	
Gas Analysis, percent by weight:	
Methane and lighter	18.1
Ethylene	11.1
Ethane	15.5
Propylene	25.4
Propane	3.3
Butane	13.0
Butylene	13.6
	100.0
Percent olefins	50.1
Gasoline:	
Gravity, °API	54.4
ASTM Distillation, F:	
Initial boiling point	136
10-percent point	202
50-percent point	281
90-percent point	362
End point	395
Research Octane Number:	
Without TEL addition	76.5
With addition of 3 ml TEL per gallon	83.0
Characterization factor, UOP	11.9
Aniline point, F.	99.0
Sulfur, percent	0.14
Gas Oil:	
Gravity, °API	27.5
Vacuum Distillation, F at 760 mm:	
Initial boiling point	400
10-percent point	500
50-percent point	760
90-percent point	1,050
Characterization factor, UOP	11.85
Coke:	
Bulk density, lb. per cu. ft.	64.0
Volatile matter, percent by weight	3.7
Ash, percent by weight	1.0
Sulfur, percent by weight	0.6

MAINTENANCE / OPERATION

the third level above grade, with the blower and lift tank on a lower level. The control room is located at grade. Advantage has been taken of the latest developments in automatic instruments for control of the coke-circulating system.

Performance

Table 1 presents feed-stock characteristics, operating conditions, yields, and product specifications of a typical run.

The feed stock to the unit was a vacuum-distillation bottoms from Texas Panhandle paraffinic crude oil, and represented approximately 10 percent on the crude. This is a much heavier charge stock than normally could be processed by a conventional delayed coking unit.

The products were metered and, wherever possible, tank gages were used. Coke production was determined by difference. Test runs under varying reaction temperatures were made. The unit operated successfully with average reaction temperatures as low as 900 F. and as high as 1025 F.

Yields for a range of reactor temperatures are presented in Table 2.

From our experience it is apparent that lower operating temperatures are practical, and could be attained by still further preheating of the feed stock to the extent that the heat of vaporization is supplied in a tubular heater and, thus, the coke temperature levels are reduced throughout. A reduction in temperature level will reduce the gas and gasoline production with a corresponding increase in the yield of gas oil.

Figure 2 presents test-yield curves vs. reaction temperatures. These curves have been plotted from actual data obtained from approximately 50 runs with varying operating conditions. The trend of the curves for each of the products is similar to yields obtained from a delayed coking operation. Compared with delayed coking, the yields from contact coking show considerably lower coke production with higher gas and gasoline yields. The important point, which is evident from these curves, is that the operating temperature range of a contact coker is much wider than can be obtained with a conventional delayed coker and, likewise, the product yields and specifications can be controlled over a wider range.

TABLE 2
Summary of Yields with Various Reactor Temperatures

Test No.:	1	2	3	4
Average reactor temp., F	1,025	985	965	955
Yields, Percent by Weight:				
C4 and lighter	18.6	17.1	15.8	14.5
C5 to 400 F gasoline	29.9	27.2	24.0	22.0
Gas oil	37.5	42.2	47.2	51.0
Coke	14.0	13.5	13.0	12.5
	100.0	100.0	100.0	100.0
Research octane number, without TEL addition, ASTM D 908 (research method), corrected to 10 lbs. RVP	84.0	80.5	76.6	75.0

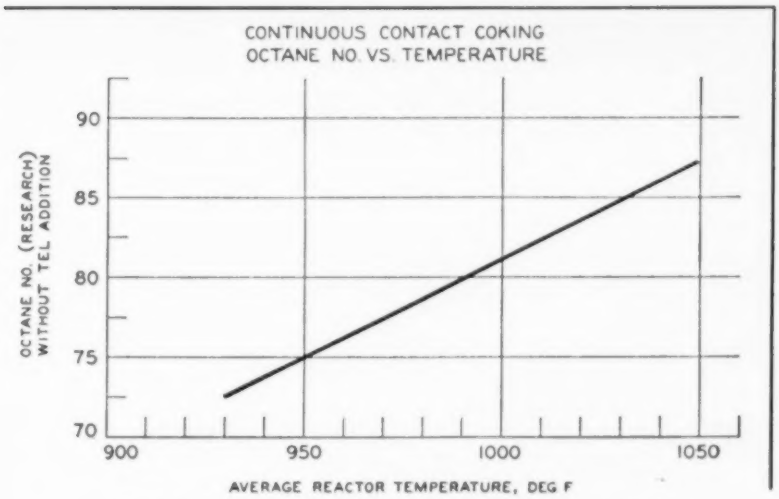

Figure 3. Correlation of gasoline octane number vs. reactor temperature

Product Specifications

Figure 3 presents the relationship between the octane number of the gasoline vs. average reactor temperature. For a reaction temperature of 950 F., the octane number, ASTM D 908 (research method), without TEL addition, is 75; whereas at a temperature of 1025 F. the octane number is 84. The lead susceptibility of the gasoline is improved approximately 6 to 8 points with the addition of 3 ml of TEL. Octane numbers of the gasoline produced on a delayed coking unit from the same paraffinic stock will run 10 to 15 points lower.

A gas analysis is presented in Table 1. It will be noticed that the olefin production is approximately 50 percent of the total gas. The corresponding yield of olefins from delayed coking is about 15 percent. This concentration of olefins could be increased considerably by operation at higher coke temperatures. Some refiners will be interested in a maximum of gas production with high olefin content for chemical-plant feed stock. A pilot unit is presently in operation to investigate the high temperature levels for maximum production of olefins.

The specifications of the gas oil from the contact coking unit are similar to gas oil from the delayed coking unit when the same heavy stock is charged. Normally the charging stock to a delayed coking unit is a long reduced crude which contains a high percentage of virgin middle distillate.

The industry today requires, and in the future will require, higher yields of middle distillates. Vacuum distillation carried to a high pitch produces a maximum of virgin distillate. The contact coker then provides a new tool to handle and convert the heavy pitch to gasoline and additional gas oil. Also the middle distillate, which normally is used as cutback to make marketable fuel oil of the vacuum bottoms, is then available for other uses.

Figure 4 is a photograph of a sample of the equilibrium coke inventory.

The coke is of high mechanical strength, and withstands shock heating and cooling without noticeable fracture or failure. It is free-flowing, and has proved to be an excellent medium for supplying the required heat to the oil. The product coke is essentially spherically-shaped, and it is approximately one-half inch in diameter. It is harder and lower in volatile content than petroleum coke which has been produced in a delayed coker. The ash content and sulfur depend on the source of the feed stock. The product coke normally is suitable for electrode manufacture when calcined.

Process Equipment

Because this unit represents a 10-to-1 increase in capacity over the 100-barrel-per-day pilot plant previously operated, some "scale-up" factor problems could be expected. The novel features of the process equipment are the oil-coke mixing system, the mass-lift system, and the coke reheater. The mixing system required considerable time to obtain perfect performance. Fortu-

MAINTENANCE / OPERATION

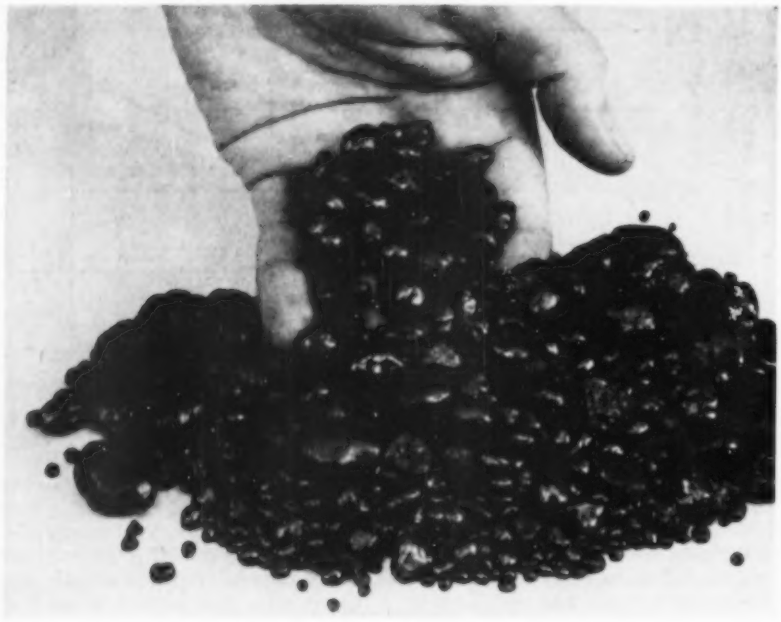

Figure 4. Typical equilibrium coke

nately the final solution is one which readily may be extrapolated to much larger sizes. The mass-lift operation was complicated by the radical difference in the characteristics of the petroleum coke used as "seed" and the equilibrium material obtained after start-up. However, minor modifications resulted in satisfactory operation.

The coke-reheater capacity was somewhat inadequate, and could not be corrected fully without extensive changes to the original equipment. The reduced heat input to the coke has limited the oil-charge capacity. Tests have shown that the other equipment is adequate for the design capacity. The unit also has operated satisfactorily at the design coke-oil ratio by reduction of the coke circulation. In a new unit the reheater deficiency can be corrected readily on the basis of data obtained during operation of this unit.

Investment and Operating Costs

Based on the experience with the 1000-barrel-per-day unit, there is under design a 2500-barrel-per-day unit which incorporates the modified mechanical features.

An economic comparison of a 2500-barrel-per-day continuous contact coking unit vs. a delayed unit has been prepared on the basis of charging Panhandle vacuum bottoms. These data are presented in Table 3. The comparison indicates that, at this capacity, the over-all economics favors the contact coking process.

When credit is allowed for the potential recovery of olefins in the product gas at a value of 3 cents per pound, the total differential profit is $2,171,280 per year. The corresponding figure for a delayed coking unit is $1,656,430 per year. The difference favors the contact coker by $514,000 per year.

The over-all operating labor required is considerably less for a contact unit. The coke drum turn-around labor, which normally consists of unheading, coke cleaning, and reheading of the drums, is eliminated. The unit is handled by two operators.

Summary

Continuous contact coking is a new process for the upgrading of heavier residues than normally can be handled by the conventional "delayed" coking method.

A continuous contact coking unit, in combination with vacuum flashing to a heavy pitch, will produce a maximum of middle distillate, and thus provide a new tool to assist in meeting the industry's need for higher yields of middle and light distillates.

The inherent flexibility of the process permits processing stocks of widely different characteristics and, by varying the operating conditions, a much wider range of yields and product specifications are obtained than heretofore possible.

The process is continuous, and thus eliminates the intermittent cleaning of coke drums and attendant expense.

The product coke is clean, hard, uniform in size, and easily handled and marketed.

The capital investment and operating labor for a contact unit are less than for a delayed coking unit.

Engineering designs for a 2500-barrel-per-day unit are now being completed.

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[3] "Lummus Continuous Contact Coking," *Petroleum Refiner* **32** [7] 104 (1953).

TABLE 3

Comparison of Contact with Delayed Coking —Processing 2500 Barrels Per Day of Vacuum Bottoms

	Contact Process		Delayed Coking Process	
UNIT:	Percent by Wt.	Percent by Vol.	Percent by Wt.	Percent by Vol.
Yields:				
Gas, C_4 and lighter	14.9	...	7.5	...
Gasoline, C_4 to 400-F end point	21.1	26.6	18.5	23.4
Gas oil	51.0	55.0	54.0	58.0
Coke	13.0	...	20.0	...
Olefins in gas	50.[1]	...	15.1	...
Utilities:				
Water, gal. per min.	1,900		2,200	
Steam, lb. per hour	13,000		10,000	
Fuel, million Btu. per hr.	29		25	
Electricity, kw.	50		50	
Operating labor, men per shift	2		4	
Investment, dollars	1,600,000		2,100,000	
Direct Charges Dollars per Day				
Raw material	2,500		2,500	
Utilities	117		363	
Labor	108		216	
Maintenance	110		130	
Total charges	3,135		3,209	
Value of products, dollars per day	8,151		7,765	
Differential profit,* dollars per day	5,016		4,556	
Differential profit,* dollars per year	1,655,280		1,503,480	
Payoff,* months	11.6		13.9	

Assumed Values of Charg-Stock, Products, Utilities, and Labor	Contact Process and Delayed Coking Process
Charging stock, dollars per bbl.	1.00
Products:	
Gas, cents per million Btu.	29
Gasoline, cents per gal.:	
80 ON	11.75
64 ON	11.00
Gas oil, dollars per bbl.	3.00
Coke, dollars per ton	6.00
Utilities:	
Water, cents per 1000 gal.	1.5
Steam, cents per 1000 lb.	55
Fuel, cents per million Btu.	29
Electricity, cents per kwh	0.75
Labor (cost per hr.), dollars	2.25

* Does not include taxes, insurance, amortization, interest and royalties.

MAINTENANCE / OPERATION

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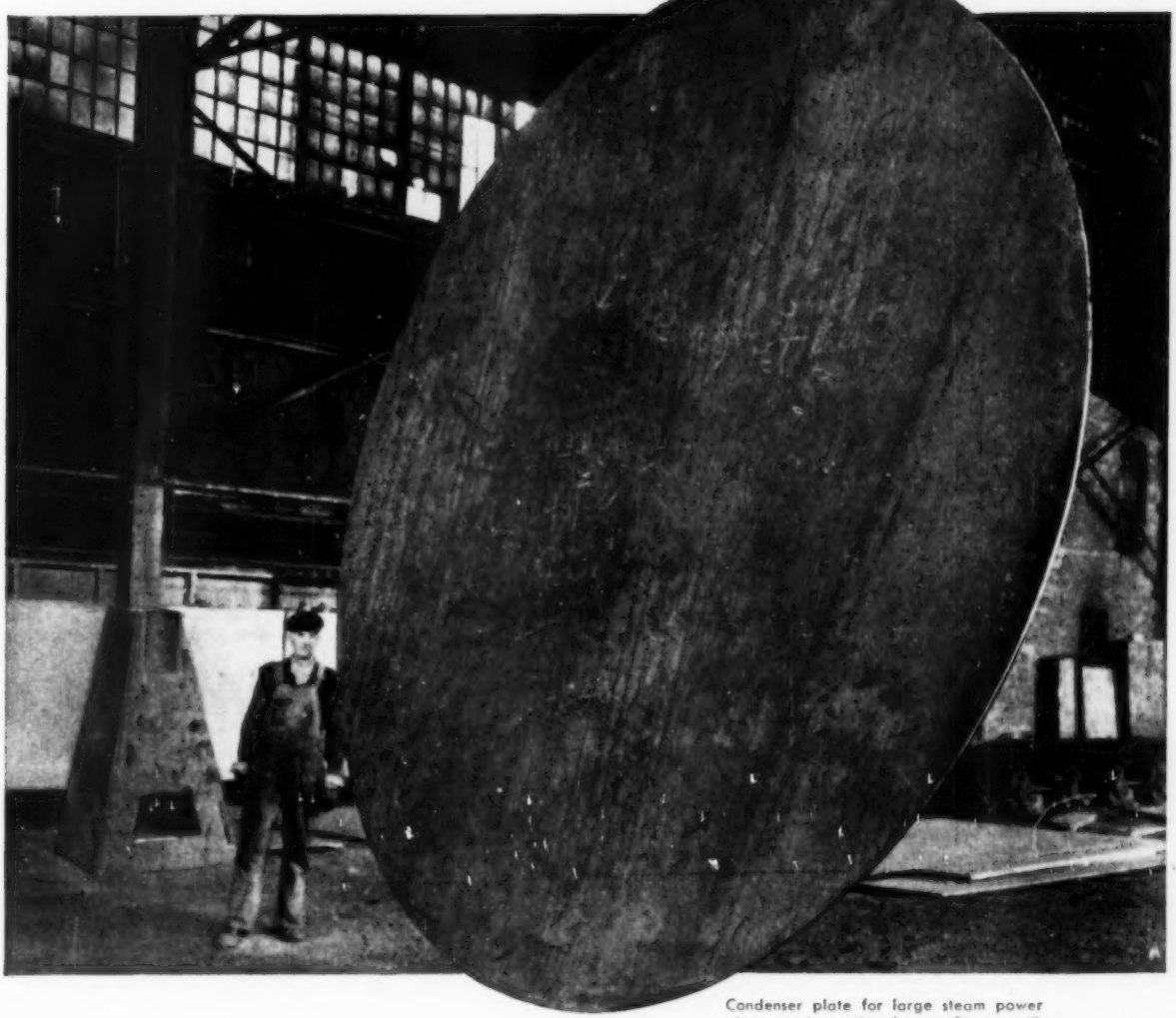

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Alexis Voorhies

H. Z. Martin

Robert M. Shirk

David B. Ardern

Voorhies and Martin Know Both Sides of Education

A. Voorhies, Jr., and H. Z. Martin, "New Fluid Coking Process Unveiled," page 127.

Both Alexis Voorhies, of Esso Standard Oil Company, Baton Rouge, La., and H. Z. Martin, of Standard Oil Development Company, Linden, N. J., have been university instructors. Voorhies, director of Esso Laboratories, Standard Oil Company (New Jersey), taught chemistry, physics and mathematics at Louisiana State Normal College from 1922 to 1924, and at Loyola University from 1924 to 1930. Martin, assistant director in Standard Oil Development's Development division, was an instructor in the Chemical Engineering department of Illinois Institute of Technology for two years.

Both men have also spent considerable time on the other end of education. Voorhies, born in New Iberia, La., received an A.B. degree from St. Charles College, Grand Coteau, La.; a B.S. degree in chemical engineering from Louisiana State University in 1922; and an M.S. degree in chemistry from Loyola in 1926. Martin, born in Chicago, was graduated from Illinois Tech with a B.S. degree in chemical engineering in 1931, went on to get a Ph.D. degree, also in chemical engineering, from the University of Michigan in 1938.

Besides teaching, Voorhies' early experience includes a stint in sugar engineering. He joined the Esso Laboratories at Baton Rouge in 1930, and has since been associated with hydrogenation, polymerization, and catalytic cracking. He was appointed director in 1947.

After his teaching years, Martin was employed in the Gas Research department of Peoples Gas Light and Coal Company, Chicago. In 1937 he joined the Development division of Standard Oil Development, where he has worked in catalytic cracking, hydroforming, synthetic fuels, and other refining processes. He was name assistant director in 1947.

Peter W. Sherwood

Sherwood Back With Article Number 19

Peter W. Sherwood, "An Auxiliary to Petrochemical Processing . . . Tonnage Oxygen," page 93.

Once again PETROLEUM REFINER is carrying an article by Peter W. Sherwood, that prolific penman from Ethyl Corporation. His current effort, number 19, assures his position as the most frequent contributor to this publication. But that's not all the story: concurrent with the writing of these 19 papers he has authored over 80 other papers—and this while he put in his regular eight (or more) hours a day!

Author Sherwood was with Blaw-Knox Chemical Plants Division before joining Ethyl. He has also served with Koppers Company. In Germany in 1945, as part of the Technical Oil Mission, he studied German synthetic and natural oil technology, subjects of some of his many papers.

His hobbies are music and languages—with the accent on French, German and Spanish. During favorable weather he enjoys swimming, golf and gardening.

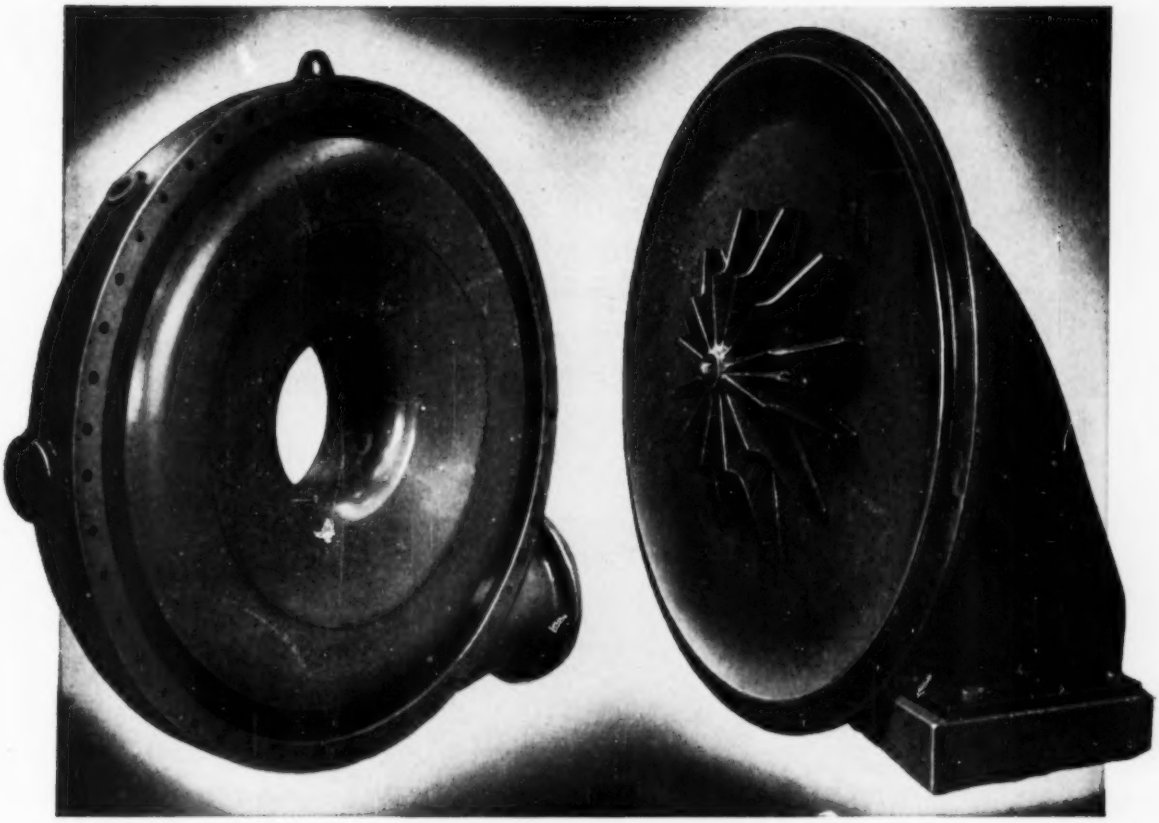
Shirk and Ardern Have Interest in Cat Cracking

Robert M. Shirk and David B. Ardern, "New Design Features of Houdriflow," page 121.

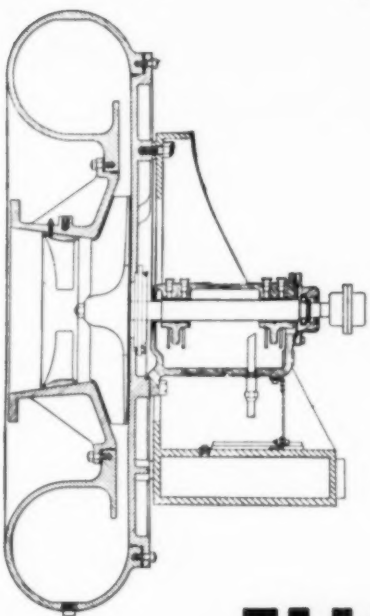
During off-hours Robert Shirk, an Isaac Walton devotee, hits the trail to his fishing headquarters on Chesapeake Bay. During these self-same "free moments," David Ardern hies himself to boy scout work, an activity in which he has been a leader for the past seven years. But when it is time to get down to business, these two converge on a common interest—catalytic cracking.

Shirk, chief mechanical engineer at Houdry Process Corporation, has visited Japan and Germany in conjunction with supervising the mechanical design of Houdriflow catalytic cracking units being built abroad. He entered the petroleum field at Sun Oil Company in 1935, transferring to Houdry 12 years later. Prior to that he worked as a naval architect at various shipbuilding companies. He studied naval architecture at Franklin Institute, Philadelphia.

Ardern, supervisor of technical service at Houdry since 1952, is the author of various papers on catalytic cracking and holds several patents in this field. He has been with Houdry since 1942, concerned primarily with process design. He received B.S. and M.S. degrees in chemical engineering at the University of Louisville, and subsequently was employed by the Tennessee Valley Authority to do research and development work.



Simplicity IS THEIR STRONG POINT



Elliott centrifugal blowers have surprisingly few parts for the work they do. The single-stage blower illustrated has a one-piece cast impeller, with no sharp corners or crevices to hold foreign matter which might cause unbalance or reduce efficiency. The major stationary parts are the casing, inlet connection, backplate and base assembly, and bearing housing. All are heavy construction with sufficient rigidity to keep vibration to an absolute minimum. Objectionable noise is kept at a low level by inlet guide vanes which pre-rotate the air or gas before it enters the impeller.

In addition to single-stage blowers of the type illustrated, Elliott also builds a complete line of multi-stage blowers. Drive can be electric motor or steam turbine, both Elliott-built. Where corrosive elements are encountered, essential parts can be made of suitable alloy materials.

For full details, consult your local Elliott representative or write Elliott Company, Jeannette, Pa.

ELLIOTT Company

CENTRIFUGAL BLOWER DIVISION

P3-2

Abe Devore

Joseph E. Heinz

Valentine Mekler

T. T. Whipple

Heinz Switch Leads to Meeting With Devore

Abe Devore and Joseph E. Heinz. "Simplified Design for Viscous Oil Heat Exchangers," page 105.

A decision in 1950 to switch from the stationary engineering field to design work sent Joseph E. Heinz to Davis Engineering Corporation as a rating engineer. Head of the Rating department at Davis was Abe Devore, his present co-author.

Devore joined Davis Engineering in 1945 and was made head of the Rating department two years later. In addition to supervising the department, he trains new sales engineers in the technical aspects of their duties.

During World War II Devore was with the Inspector of Naval Materiel as petroleum engineering inspector. In 1942 he joined Kellex Corporation, the Manhattan project of the Atomic Energy Commission, as a chemical engineer. He received his B.S. degree in chemical engineering at Cooper Union in 1940, his M.S. degree in 1949. His favorite diversion is symphonic music.

Heinz was graduated from the U. S. Merchant Marine Academy at Kings Point, N. Y., with a B.S. degree in marine engineering in 1949. He explored the stationary engineering field for one year before deciding on design work.

Lummus Trio Knows Subject From Experience

Valentine Mekler, A. H. Schutte and T. T. Whipple, "The Lummus Continuous Contact Coking Process," page 131.

This writing threesome, all from The Lummus Company, is well qualified to write on the Lummus continuous contact coking process, each member having been closely associated with it.

Valentine Mekler, presently senior technical specialist at Lummus, came to the U. S. from Russia, where he was born, in 1921. He received a B.S. degree from the University of Pittsburgh in 1925, after which he joined Warner-Quinlan Company. From 1927 to 1935 he was with University Oil Products Company, where, as a group leader, he was in charge of UOP's process design and operation. He joined Lummus as a process technologist in 1935.

Born in Boston, August Schutte was graduated from Dartmouth College with an A.B. degree in 1929. In 1930 he re-received an M.S. degree in chemical engineering and an M.S. degree in chemical engineering practice from Massachusetts Institute of Technology. During his four years with Standard Oil Company of Sumatra he was involved in almost every phase of refinery operation. He returned to the U. S. in 1934, joining The M. W. Kellogg Company. In 1935 he became a process design and project engineer with Lummus. He is presently vice president-technical consultant at Lummus.

After receiving a B.S. degree in mechanical engineering from the Carnegie Institute of Technology in 1929, T. T. Whipple joined The Atlantic Refining Company as plant engineer on general refinery design and maintenance. Since 1936 he has been with Lummus as chief project engineer on refinery and chemical plant design and construction. At present he is chief development engineer at Lummus.

Walter B. Howard

Howard Keeps Busy During Leisure Hours

Walter B. Howard, "Applying Henry's Law to Concentrated Gas-Solvent Systems," page 97.

Dr. Walter B. Howard is a Texas man. His degrees, B.A. and B.S. in chemical engineering, M.S. in chemical engineering, and Ph.D., were all received at the University of Texas. During his years as a graduate student, he was awarded a University scholarship and a University fellowship. For ten years he was associated with the Bureau of Industrial Chemistry at the school, assisting on Dr. Schoch's electric discharge project used in the acetylene-from-gas process.

A registered professional engineer, he is presently in Monsanto Chemical Company's Research department at Texas City, Texas.

Howard is a very active hobbiest. He holds a life membership in the University of Texas Men's Glee Club, is skilled in woodworking (major interest in period furniture), and enjoys at every opportunity swimming and salt water fishing. With this long list of spare-time activities, he still manages another more serious hobby: the study of process control through instrumentation.

Gilmore Remembers Unusual Sea Venture

J. F. Gilmore, Jr., "Short Cut Estimating of Processes," page 97 of the October, 1953, PETROLEUM REFINER.

For the past three years, J. F. Gilmore has been with the Chemical Plants division of Blaw-Knox Company in Tulsa, only recently moving to senior engineer in the Estimating department. He is a graduate of the University of Florida with a B.M.E. degree.

Soon after graduation he joined two other students and an ex-professor in a sailing venture. They left Florida in a 28-foot Swedish-designed sloop which had no engine, landing in Houston after seven weeks and several harrowing experiences. From Houston he moved to Tulsa and joined Refinery Engineering Company. And that is how Gilmore migrated to the Southwest.

Meet Our Authors. . .

You're Sure of Tighter Seating with Crane Steel Gates

...in a Butadiene Plant, for instance

THE INSTALLATION

At a Southwestern butadiene plant, using Crane 18-inch steel gate valves on suction lines from extractive distillation towers to pumps. Working pressure, 90 psi, 250 to 300 deg. F.

VALVE SERVICE RATINGS

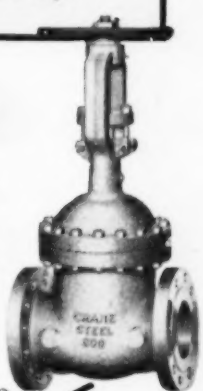
SUITABILITY:	Have what the job takes
FEATURES:	Epelloy seating
MAINTENANCE COST:	Zero
SERVICE LIFE:	Installed 1951-long life ahead
OPERATING RESULT:	Valve efficiency restored
AVAILABILITY:	Catalog item—No. 33X

THE CASE HISTORY

Original valves in this service were lubricated plug valves, but they couldn't be made to seat tightly on the light hydro-carbons and furfural mixture. Their continual leakage burdened the plant with excessive maintenance, and a constant threat to process control. All these lubricated plug valves were replaced with Crane 33X steel wedge gate valves.

Installed more than 2 years ago, the Crane valves completely remedied the leakage trouble, and to date, none have required any maintenance whatsoever. They keep working perfectly with but prescribed routine care.

THE VALVE



Product of pioneer skill in steel casting, and with a long record of service to petroleum and petrochemical industries, Crane steel valves stand apart from the ordinary. Yet they actually cost less for service delivered. Choose from the widest range of body and trim materials; in all pressure classes, sizes; flanged, screwed, or welding ends. See your Crane Catalog.

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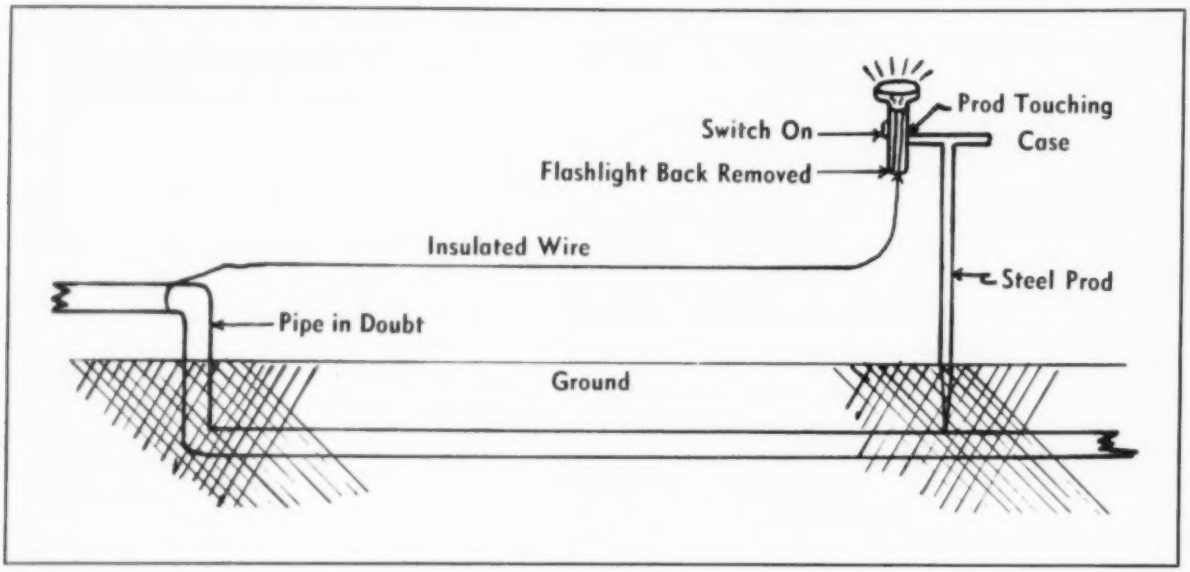
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

How to Do It . . .



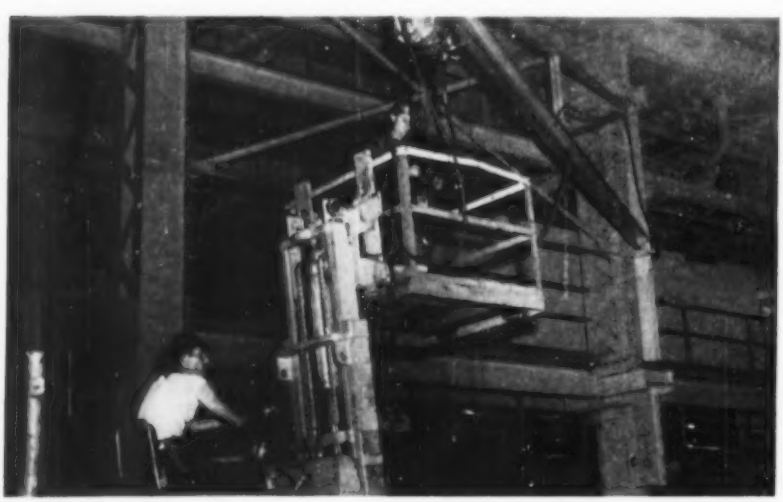
Light Means Right Pipe

Have trouble finding the right pipe when lines are buried? This clever flashlight method is practically foolproof.

When pipe lines are numerous and buried, as they frequently are, and jeep signals are confused, determination of the right line can get to be a downright tricky problem. For the solution of this problem, Glenn G. Morgan, Salem, Ill., has come up with a method that will work in practically every instance. Though basically simple, this clever idea is almost always sure-fire.

Materials. All that is needed in employing this method is a flashlight, any insulated wire, which can usually be found around any shop, a prod or any reasonable facsimile, and, of course, the problem.

Application. First thing to do is remove the back from the flashlight. After attaching one end of the wire to the pipe in question, string it back down the general line of the pipe and attach the other end to the bottom of the flashlight batteries. Set the flashlight switch in "on" position, and then ram the prod into the ground until contact is made with a pipe believed to be the right pipe. When the side of the flashlight is held against the prod which is making contact with the pipe, the light will burn—if the pipe is one and the same. If the light's on, you're in—if the light's off, try again!

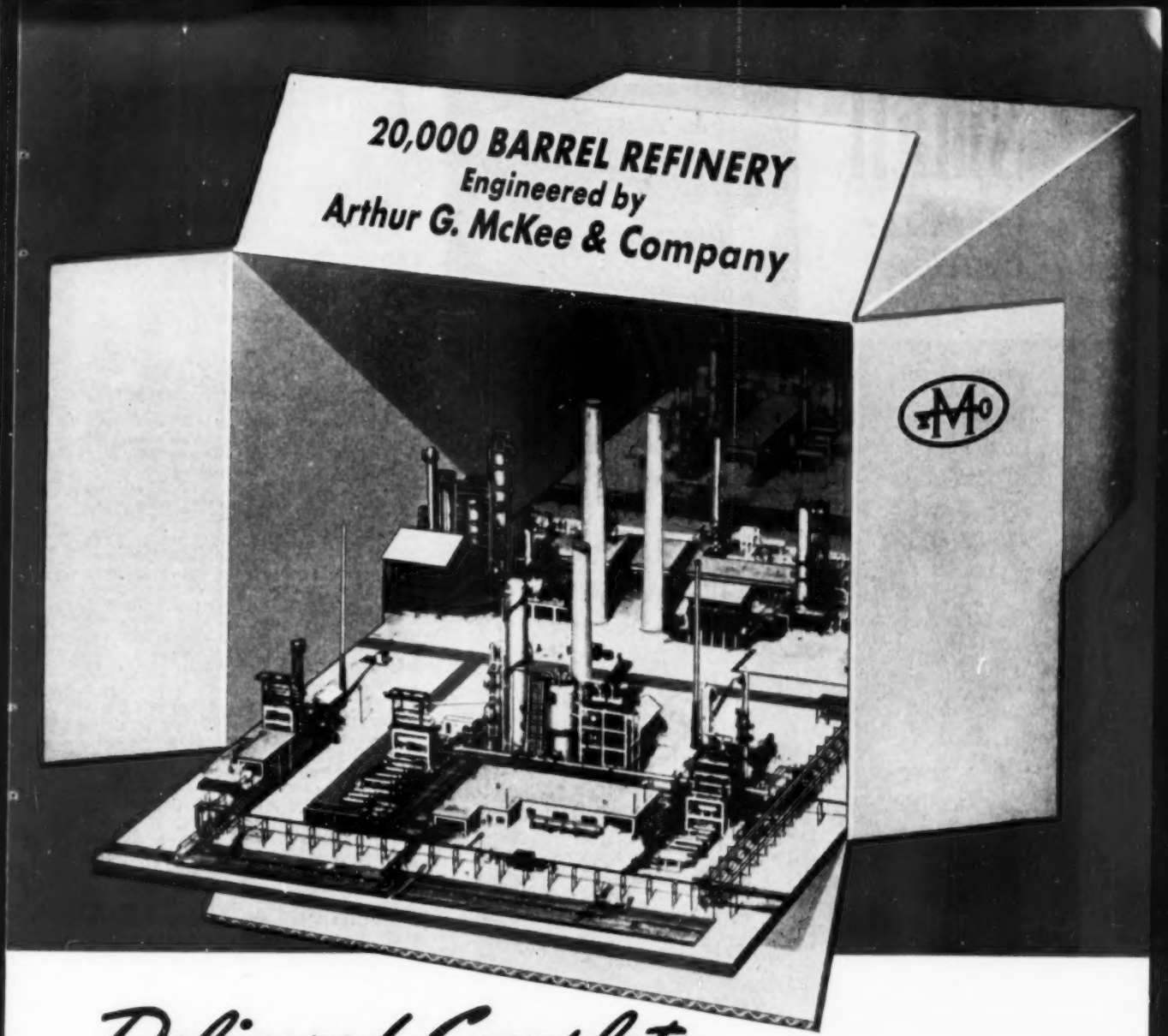


Fork Lift and Cage Takes Danger Out of High Work

The photograph shows a mechanic working over a block and tackle assembly from the roof of a shop building. He works in safety and comfort because of the convenient cage used in conjunction with the fork lift truck.

The cage was shop-built of steel bands supported by a wooden pallet. The fork lift truck easily scoops up the pallet and raises the mechanic to the desired height for his work.

Net construction time for the cage: less than five hours. Approximate cost: $25.00. Here is a worthwhile device that features both safety and convenience.



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McKEE does the complete job — design engineering, purchasing, construction, installation of equipment—everything, down to the last detail, ready for initial operation.

Most of it is an old story with us (we've been doing it for many years in many countries) but we are constantly alert to new requirements of the processing industries—constantly improving plant design and construction. That's one of the reasons the McKee organization has established a world-wide reputation for sound, practical, *up-to-date* engineering of all types of petroleum and petro-chemical processing facilities.

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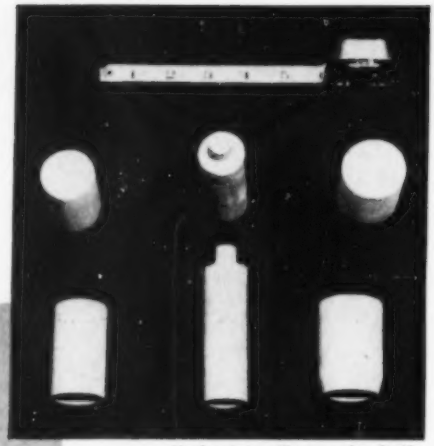
Small

HIGH ALLOY
CASTINGS

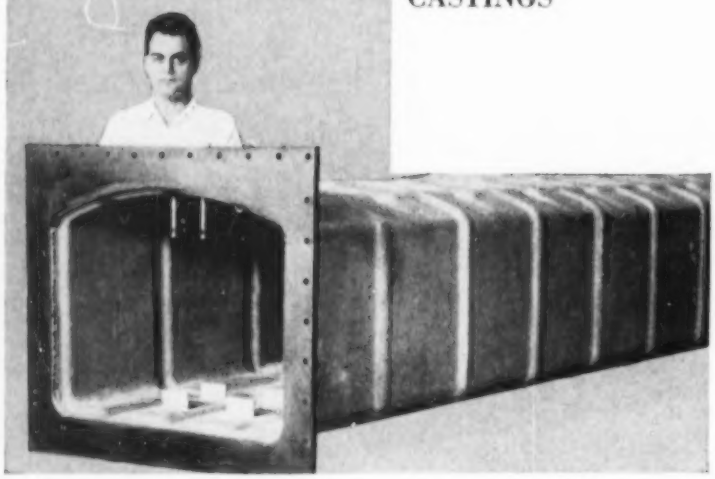


Carburizing Fixture for Ball Bearings 11½" diameter—Analysis 35% Ni — 15% Cr

DURALOY

Large

HIGH ALLOY
CASTINGS



Muffle for Continuous Strip Annealing 12' 6" long — Analysis 38% Ni — 18% Cr.

LARGE or small DURALOY, can do it! These are just typical examples of the work moving through our foundry. Some of these castings are designed for heat resistance, some for corrosion resistance, some for abrasion resistance; all are cast by experienced foundrymen. All are carefully tested in our up-to-date laboratory.

If you have a high alloy casting problem . . . LARGE or small, we can help you. For more information, send for Bulletin No. 3150-G.

THE DURALOY COMPANY

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Who's Building . . .

uled for testing early last month. Most pumps for this unit have been installed, the magazine reported.

Revamp work on the absorption and stabilization unit is under way preparatory to tying this phase into the new processing units. The delayed coking vessels are also taking shape. One whole vessel is in position and workers are proceeding on the welding job.

British Columbia Standard Lets Cat Cracker Contract

A Canadian subsidiary of Fluor Corporation, Ltd., has been awarded a contract by a Canadian subsidiary of Standard Oil Company of California for engineering and construction of a Fluid catalytic cracking unit at Burnaby, near Vancouver, B. C.

Fluor Corporation of Canada, Ltd., will get engineering work under way immediately, with actual construction to start next March on the unit for Standard Oil Company of British Columbia, Ltd. Completion of the unit, a Standard Oil Development Company Model IV, is scheduled for next October 1. The unit will have a fresh feed capacity of 3750 barrels a day.

The proposed cat cracker is part of the $10 million new refinery program announced by Standard earlier this year. The new plant is being built adjacent to the firm's old 8500-barrel-a-day refinery at Burnaby, which is to be shut down when the new refinery is completed by the end of next year.

The new refinery will have a daily capacity of 11,000 barrels of Alberta crude oil. At present the refinery's basic refining stock is California crude oil shipped north by tanker. Besides the cat cracker, the refinery project will include related facilities consisting of fractionation, gas recovery, and caustic treating sections.

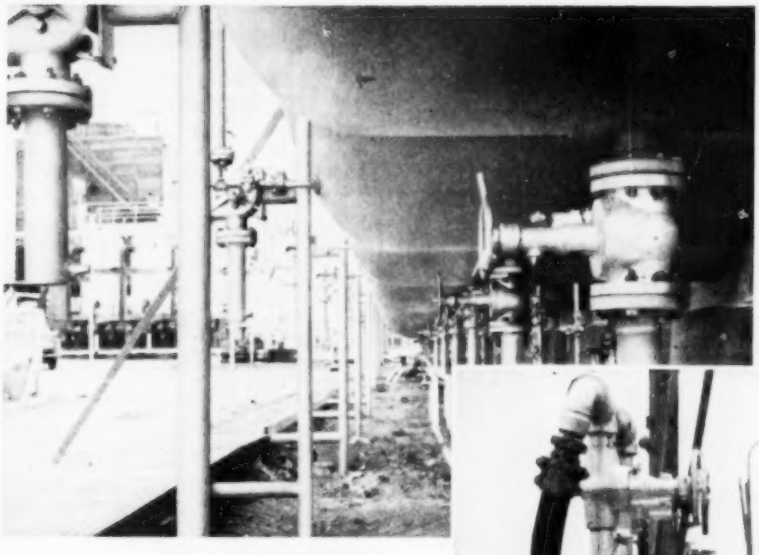
Signal Ready to Build New Natural Gasoline Unit

Signal Oil and Gas Company has completed arrangements to build and operate a natural gasoline plant in Carter County, Okla. Engineering and design work is already under way for this plant which will be built in the Fox-Milroy area of the Ardmore Basin. Designed to process 40 Mmcf of gas a day, with a capacity of 100,000 gallons of LPG and natural gasoline, it is being built by Signal with the assistance of Fox Gasoline Company, which will work in conjunction with Signal engineers and management personnel in the design, construction and operation of the plant.

Signal is presently building a natural gasoline and sulfur extraction plant at Tioga, N. Dak., which will be in operation next spring.

Macco Holds Contract For Offsite Facilities

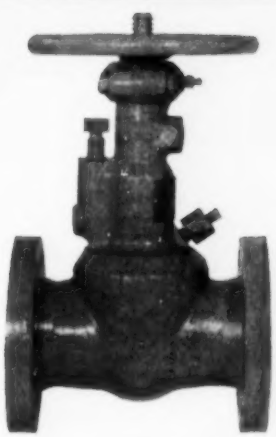
Macco Corporation has been awarded the contract to build offsite facilities at the El Segundo, Calif., refinery of Stand-



ORBIT VALVES ®

For SAFER Handling of LP-Gas from Plant to Loading Rack

Void areas are eliminated in the body of Orbit Valves . . .



A cross section view is furnished to show this important feature. When the valve is closed it drains clean to either side of the line. Orbit's Friction Free Seating principle gives a positive shut-off on both the down stream and up stream end of the valve. A simplified but rigid control mechanism makes this possible. The seat is vapor tight when closed.

The body is vapor tight too because both body and bonnet are made of dropped forged steel — the bonnet is welded to the body to form an integral unit.

Orbit Forged Steel LP-Gas Valves are rising stem type with adjustable plastic stem packing. Full Round opening type in sizes 1" to 4" Flanged or Screw end, ASA Class. Maximum rated working temperature 250 Degrees Fahrenheit.

For Fast Regional Service call ORBIT'S Offices located in —

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SPARKLER
HORIZONTAL PLATE
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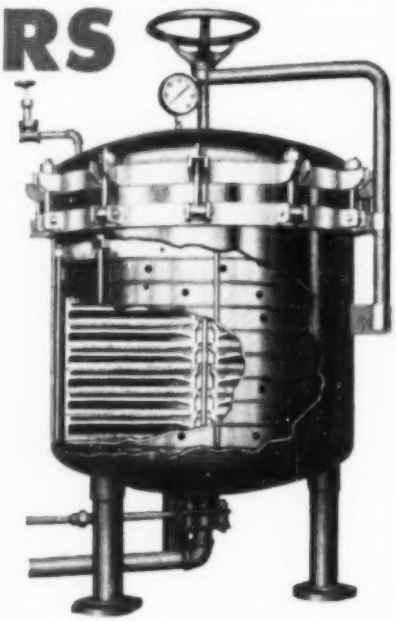
Noted for High Quality, Consistently Uniform, Fine Sharp Filtration of Petroleum Products....



Many times Sparkler filters have been chosen by experienced filtration engineers in the petroleum field because of these specific features of superiority.

Sparkler filters deliver unusually high flow rates due to the horizontal plate construction that requires only a very thin precoat to produce fine sharp filtration right from the start. Less pressure is required with a thin precoat resulting in a filter cake of less density and high flow capacity. Intermittent operation or variation in pressures will not disturb the stability of the filter cake.

Any grade of filter paper, cloth, or screens, and any filter aid can be used with maximum efficiency because no pressure is required to hold the filter cake on the plate.

Frequently Sparkler filters are used in the petroleum industry with various grades of paper only without filter aid to perform a specific job that would be difficult or impossible with some other types of filters such as the removal of water from diesel lube oil or transformer oil.

A few typical applications of Sparkler Filters to the Petroleum and petro-chemical industries for the filtration of:

- Canned lubricating oil
- Methyl-Ethyl-ketone
- Polyisobutane
- Chlorinated hydro-carbons (carbon tet.)
- Aviation gasoline
- Jet engine fuel
- Hydraulic oil
- Gas engine & diesel lubricating oil (both continuous recirculation on the engine and batch-wise)
- Diesel fuel oil
- Cooling tower water
- Plant effluent water (to obviate stream and lake pollution)
- Removal of Raney nickel from alcohol streams
- Insecticides
- Caustics & acids
- Cottrell precipitator insulating oil (carbon black plants)

Sparkler horizontal plate filters are available in capacities from 30 to 30,000 G.P.H. depending on type of product filtered. Can be supplied in carbon steel, stainless steel, pure nickel, or monel, bronze, Hastelloy and Inconel. Rubber lined, brine or steam jacketed.

Sparkler representatives for personal engineering service are located in Dallas, Houston, San Francisco, and other principal cities. Western Branch, Los Angeles, California.

SPARKLER

Write Mr. Eric Anderson for your nearest Sparkler service representative.

MANUFACTURING COMPANY
MUNDELEIN, ILL.

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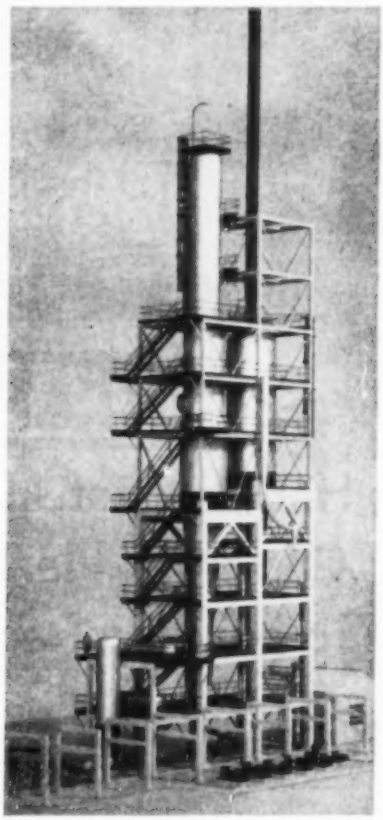
MAKERS OF INDUSTRIAL FILTERS FOR OVER A QUARTER OF A CENTURY

Who's Building...

ard Oil Company of California, and not The Fluor Corporation, Ltd., as reported on page 201 of the October PETROLEUM REFINER. Fluor is, however, doing much of the other work under way at Standard's El Segundo plant.



Carter to Build at Billings—

A new Fluid coking unit, first commercial installation of its kind in the world, will be built at Carter Oil Company's Billings, Mont., refinery. The Fluor Corporation, Ltd., has been awarded the contract for the engineering, procurement and construction of the unit, which was developed by Standard Oil Development Company. Detailed engineering work will get under way immediately, although Fluor will not begin actual construction of the new unit until next spring.

Addition of the Fluid coker is the first step in an extensive expansion at the refinery. It marks the fourth major improvement in the refinery since it was opened in 1949.

As may be seen by the scale model above, a 120-foot tower with stairways leading to the nine platform-floors will dominate the coking unit. The Fluid coking process has just been perfected after four years of research. The Carter unit will probably be completed and ready for operation by October, 1954.

Rothschild Goes on Stream With New UOP Platformer

Rothschild Oil Company has become the first independent refiner in California to put a UOP Platformer on stream. The unit, built entirely by Rothschild

PETROLEUM CHEMICALS DIVISION

NEWS

December ★ One of a Series of Interest to the Petroleum Industry ★ 1953

Use of Antioxidants Cuts Sweetening Costs

With operating costs continuing to rise and the consumer gasoline market becoming more competitive every day, you are probably looking for every possible opportunity to cut production costs—without sacrificing quality.

The use of antioxidants for sweetening offers just such an opportunity. If you are starting from scratch, the initial cost is low because a minimum of equipment is required to set up the operation. Or, if you employ existing equipment, the cost of revamping is exceedingly low since antioxidant sweetening is a simple procedure.

Operating costs are lower, too, because the use of Du Pont Antioxidant No. 22 reduces regeneration expenses and the need for additional chemicals.

Other Advantages

Since antioxidant sweetening does not require the use of sulfur or copper, the chance of contamination from these elements is eliminated — unless the gasoline comes in contact with them in some other way.

And since Du Pont Antioxidant No. 22 is highly effective as a stabilizer, you can combine two important steps into a single, inexpensive operation when you use this additive as a sweetening agent.

No Gasoline or Octane Loss

Some sweetening methods result in a definite loss of gasoline or octane number. But there is no loss of either product or quality when Du Pont Antioxidant No. 22 is used in the sweetening process.

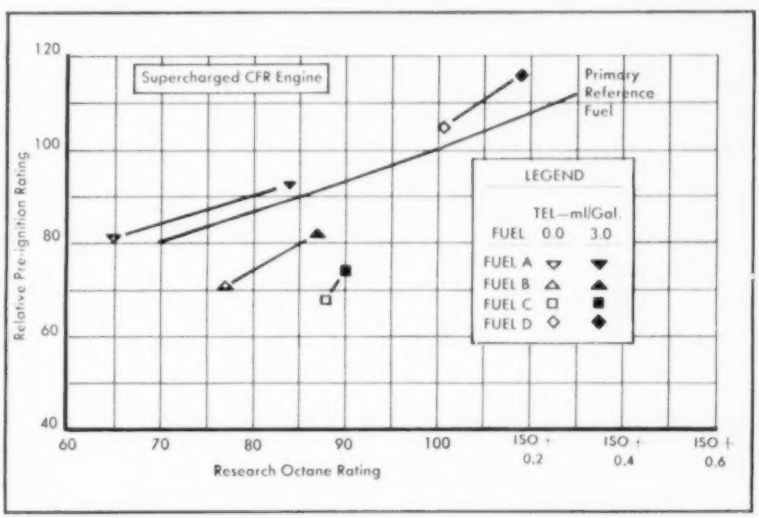
Du Pont Antioxidant No. 22 is N:N'-di-secondary butyl-para-phenylenediamine. Samples of it and additional information on antioxidant sweetening are available through any Du Pont Petroleum Chemicals Division district office.

You can reduce both knock and pre-ignition with one additive

Recent tests at the Du Pont Petroleum Laboratory show that TEL not only inhibits the reactions leading to knock, but also the reactions causing pre-ignition

With the compression ratios of automobile engines steadily rising, the problem of finding methods to eliminate or suppress pre-ignition is becoming increasingly important to the petroleum industry.

To help refiners solve this problem, extensive research in pre-ignition is now being done at the Du Pont Petroleum Laboratory. Much useful information has already been developed.



This chart shows the increased resistance to knock and pre-ignition due to the addition of tetraethyl lead in several fuels.

So far, the solution to the problem has been sought in the following two ways:

1. Reducing the tendencies of combustion chamber deposits to glow and cause surface ignition of the charge.

2. Improving the ability of fuels to withstand ignition by such hot surfaces.

Reducing Glow

Certain additives reduce deposit glow and therefore offer one solution to the problem. However, as engine compres-

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OVER

DU PONT

PETROLEUM CHEMICALS DIVISION
NEWS

DU PONT

CONTINUED *Pre-ignition*

sion ratios are increased still further, it may also be necessary to increase the pre-ignition resistance of the fuels themselves.

Resistance of Fuels

Some hydrocarbons have a greater tendency to be ignited by hot deposit particles than others. Preflame reactions also tend to sensitize the fuel to ignition.

Effect of TEL

The effect of these preflame reactions can be minimized by raising the octane rating of the fuel with tetraethyl lead. In this way, *tetraethyl lead* not only prevents knock . . . but *also reduces the tendency for the fuel to be ignited by a hot surface.*

More Information

More complete details on the Du Pont Petroleum Laboratory's pre-ignition studies are now available to you through any Du Pont Petroleum Chemicals Division district office. Ask for papers entitled "Pre-Ignition in Automotive Engines" and "An Investigation of Pre-Ignition in Engines."

New Lube Oil Show to Help Marketers Stimulate Dealer Promotion

A new lube oil presentation for dealer meetings is now being made available to oil marketers by the Du Pont Petroleum Chemicals Division.

It is especially designed to help you impress your dealers with the value of promoting more frequent oil changes. The same "flannelboard" visual-aid technique as used for the highly successful Du Pont-designed *Brand Name* program is employed for putting across this new promotional tool.

The general theme of the show is: "Good oil seldom wears out . . . but it can become dirtied to death." The individual points emphasized in the presentation can be personalized to bring out the special quality features of your own brand of motor oil.

If you are interested in having one of these personalized lube oil presentations made up for use in your own dealer meetings, we suggest that you talk over the details with a Du Pont Petroleum Chemicals Division representative.

Assistant West Coast District Manager

WILLIAM B. GEST, recently appointed assistant manager of the Petroleum Chemicals Division's West Coast district, has been with the Du Pont Company since 1941.

Until 1945 he served in various engineering capacities at a number of Du Pont-operated government ordnance plants. He then spent two years doing cost engineering work in the Engineering Division and at several company plants.

He joined the Petroleum Chemicals Division in 1947 as a sales-service representative.

Mr. Gest studied engineering and military explosives at Ohio State University, where he also received a B.S. degree in Business Administration.

WILLIAM B. GEST

Du Pont Test Cars Show How to Take the "Toll" Out of Toll Roads

Super highway toll roads and fuel test cars have both been around for a long time.

But it took the ingenuity of a major oil company to put the two together and come up with some amazing results.

When the Garden State Parkway in New Jersey was opened last summer, two Du Pont test cars were on hand for the official opening ceremony. Their job, however, was far more important than merely looking decorative in the official caravan.

Sponsored by one of the large oil companies marketing in the New Jersey area, the cars were used to show the Highway Authority how the new parkway saves the motorist 40% on gasoline mileage and at least 25% in time when compared with the old traffic-congested route.

After the results of the test had been tabulated, the Garden State Highway Publication declared that motorists will save more than the parkway toll by using the new road because of the gasoline savings it makes possible.

LITERATURE AVAILABLE

Here is a partial listing of the bulletins, reports, booklets, technical papers and aids available to you through any of the Du Pont Petroleum Chemicals Division district offices listed below:

Pre-Ignition in Automotive Engines — This paper discusses mainly the glowing tendencies of combustion chamber deposits and the pre-ignition tendencies of individual hydrocarbons Serial A-5652

An Investigation of Pre-Ignition in Engines—A comprehensive discussion of how compression ratios and other mechanical factors affect pre-ignition. Also the effect of tetraethyl lead in reducing pre-ignition Serial A-5756

Du Pont Fuel Oil Additive No. 2—A 12-page bulletin describing this ashless stabilizer and dispersant which prevents clogging of fuel oil screens Serial A-5201

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A-6350

Printed in U.S.A.

Who's Building. . .

personnel, has a design capacity of 1000 barrels a day.

Universal Oil Products Company licensed the unit and did the designing and engineering work.

Anglo-Iranian May Beat Refinery Completion Date

On the basis of progress so far, the 100,000-barrel-a-day refinery which Anglo-Iranian Oil Company is building at Aden, on the Red Sea, may be completed before its scheduled completion date in late 1954.

The Aden refinery—largest of seven now under construction in the Indian Ocean area—is being built at a cost of about $140 million. It will operate largely on crude from nearby Kuwait, where Anglo-Iranian owns a concession jointly with Gulf Oil Corporation. This installation will help offset Anglo-Iranian's loss of production when its Abadan, Iran, refinery was nationalized.

Since pouring of concrete for major units began in June, erection of refinery units has progressed steadily. Much of the underground pipe line network is also in place. At present, about 10,000 men are at work at the refinery site, including Americans and local labor. Middle East Bechtel Corporation and George Wimpey & Company are contractors for the new refinery.

Ohio Adds Cat Cracker To Wyoming Refinery

A catalytic cracking unit was scheduled for installation last month by The Ohio Oil Company at its Lovell, Wyo., refinery. The new unit will produce higher octane gasoline from local crudes, substantially increasing the amount formerly obtained. In addition, it will increase yields of burning fuels.

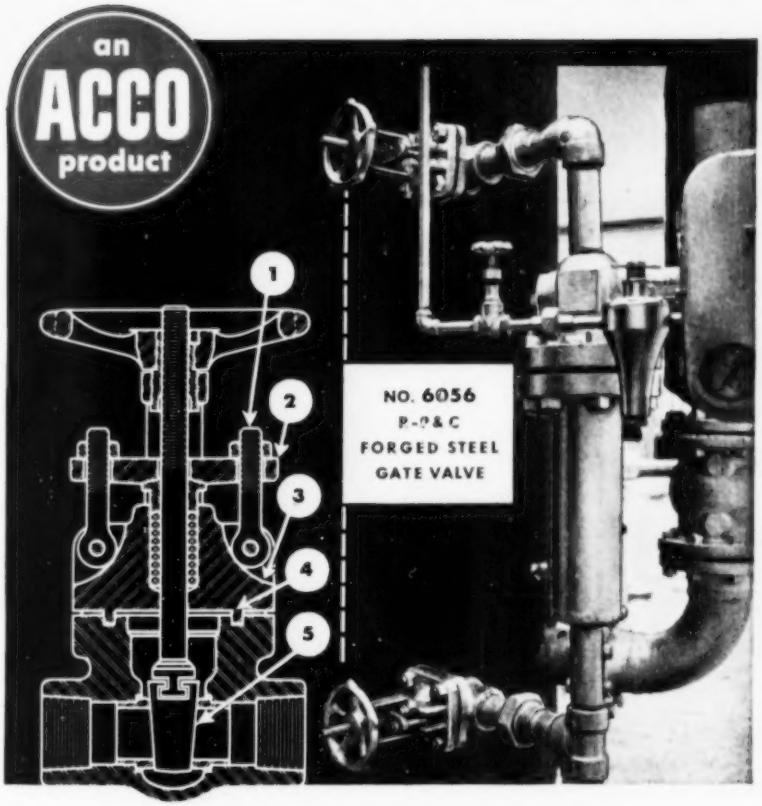
A package-type unit, the new cat cracker was expected to be completed and operating last month. The new unit was being installed by Grebe and Doremus Process Company. A fixed-bed catalytic cracker, the process is licensed by Phillips Petroleum Company.

Monsanto Picks Texas City For Polyethylene Plant

Texas City, Texas, has been selected as the site for Monsanto Chemical Company's first polyethylene production plant. Plans for the new unit, to be located next to the company's present plant in that city, were announced last March, when initial annual capacity was set at about 66 million pounds, with a 50 percent increase scheduled for 1957. At that time the site had been chosen, but construction work is just now getting under way at Texas City.

Berry Asphalt Leases 7000-Barrel Gary Plant

Berry Asphalt Company has completed negotiations for a long-term lease of a 7000-barrel-a-day refinery at Gary,



1 Stainless steel bolts and nuts. 2 Two-piece gland and follower.
3 Bolted bonnet. 4 Tongue and groove joint.
5 Hardened wedge, chrome plated.

Why Gas Absorption Plant Chose These R-P&C Valves

● Because of the plant's isolated location the engineers felt they should standardize on a type of valve which could be used on different lines even though chemical solutions, temperatures, and pressures varied. The No. 6056 R-P&C Forged Steel Gate Valve proved to be the answer for several reasons.

First of all it has a pressure range from 380 lbs. at 1000° F., up to 2000 lbs. at 100° F. Then with its chrome stainless trim and chromium plated disc, it has high resistance to corrosion. On top of this, it's easy to service with its stainless steel gland bolts, and two-piece gland and follower.

Best of all, although the R-P&C Forged Steel Valve is premium quality it is NOT premium priced. It comes in sizes from ¼" to 2" with screwed or welding ends. If you use valves in these sizes, see your R-P&C distributor today or write our Reading, Pa., office for literature.

ACCO
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R-P&C VALVE DIVISION
AMERICAN CHAIN & CABLE
Reading, Pa., Atlanta, Baltimore, Boston, Chicago, Denver, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Bridgeport, Conn.
R-P&C valves

Alco

Answers to

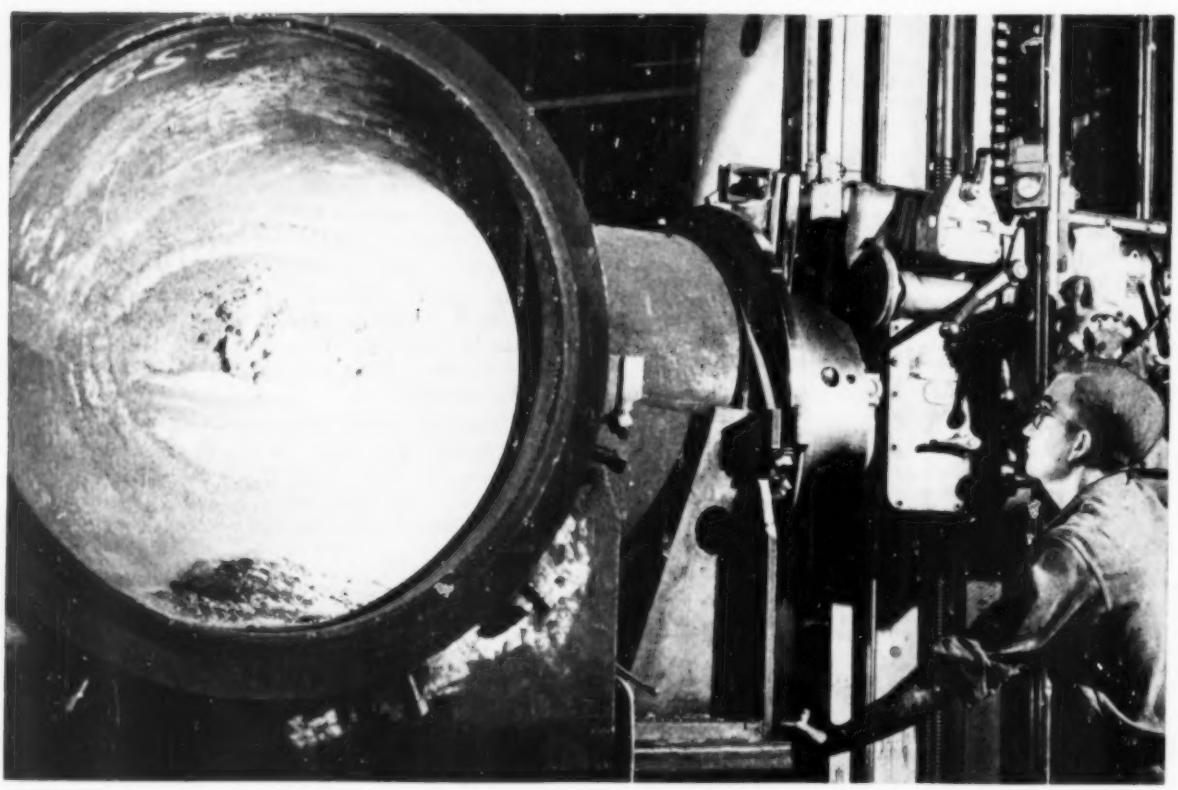
...in power, processing,

Among the many problems solved by equipment shown on these pages, one or more may be related to your own.

When such problems arise, call on the experience gained by Alco in designing and building an endless variety of equipment for plants and municipalities the world over. Call on the complete, modern production facilities that enable Alco to meet *economically* your strictest specifications.

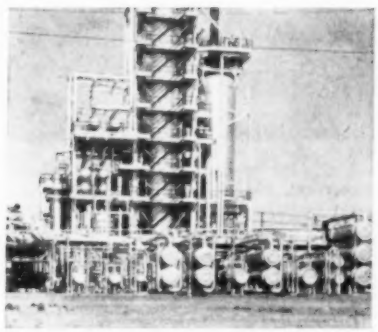
Your nearest Alco Products sales representative will be happy to give you full information in terms of your own requirements. Contact him at New York, Chicago, Dunkirk, Los Angeles, Kansas City, Houston, Tulsa or Beaumont.

WITH MODERN PRODUCTION FACILITIES capable of handling virtually every type of metal fabricating operation, Alco can help you solve your toughest heavy-equipment problems. Here, using a special jig, an Alco craftsman faces a flange on a 42-in. smooth-flow pipe elbow that was formed to size on Alco's 750-ton press.

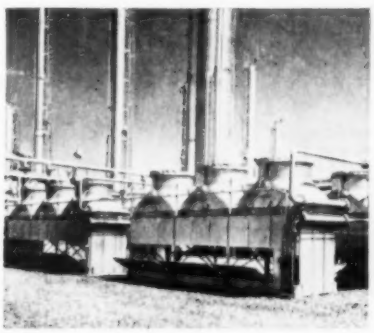


New Industrial Problems

water supply

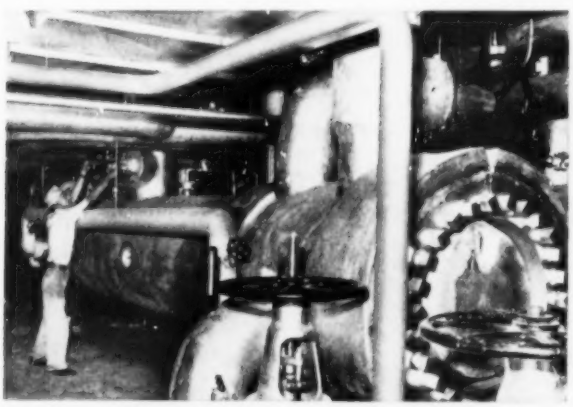


SPECIAL HEAT EXCHANGERS, designed and built by Alco to meet individual customer requirements, help boost efficiency, cut operating and maintenance costs on Carter Oil Company crude unit at Billings, Montana.

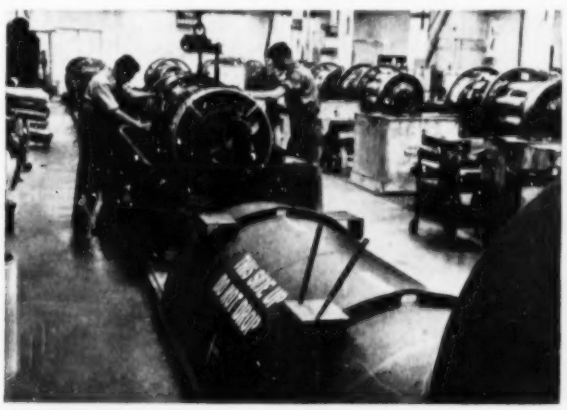


ALCO AIRCOOLERS used in the modern pressure maintenance and processing plant operated by Stanolind Oil & Gas Company at Elk Basin, Wyoming. These rugged, versatile units are unsurpassed for efficient heat dissipation in arid regions.

MORE THAN 200,000 FT of durable, economical Alco Electric Welded Steel Pipe, ranging in diameter from 20 to 72 in., have been installed over the years as part of the gigantic water-supply system of New York City.



ALCO FEEDWATER HEATERS, some incorporating special Alco-designed desuperheating and subcooling sections, contribute to the efficiency of the Carolina Power and Light Company's new 150,000-kw plant at Goldsboro, N. C.

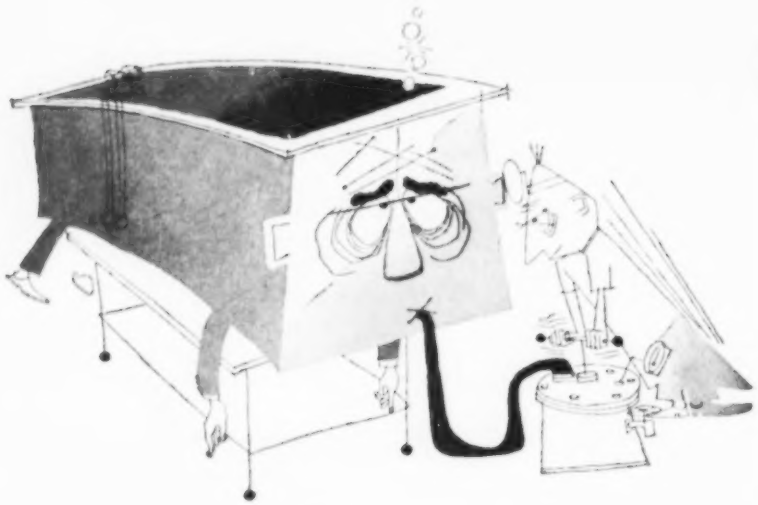


PRESSURE-SEALED STEEL CONTAINERS for jet engines, assembly-line produced for the U.S. Air Force, illustrate Alco's ability to design and build special metal equipment to almost any specifications, in almost any quantity.

ALCO

ALCO PRODUCTS DIVISION

AMERICAN LOCOMOTIVE COMPANY • DUNKIRK, NEW YORK



has **coil-itis*** cramped your production flow?

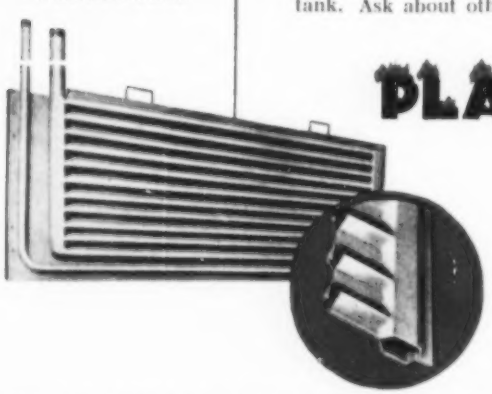
It's a waste of costly time to pump out the solution every time your process heating and cooling tanks get indigestion due to pipe coil troubles. You can save this cost and eliminate production bottlenecks by replacing the pipe coils with Platecoils. Platecoils can be removed and replaced **without dumping the solution**. They simplify maintenance and save hours of downtime. They heat or cool 50% faster and take 50% less space in the tank. As revolutionary as the new wonder drugs, Platecoils cure production troubles involving heat transfer . . . and give profits a shot in the arm.

Write for bulletin P78 today!

PLATECOILS SAVE 50% IN HEAT TRANSFER COSTS

PLATECOILS TRIPLE PRODUCTION

At Continental Motors Corp., 3 crankcase sections can be cleaned at one time when Platecoils are used while only one crank case can be cleaned with pipecoils in the tank. Ask about other case histories.



PLATECOIL

REPLACES PIPE COILS

*

Coil-itis — Diagnosed as tank heating and cooling problems. **Platecoils** — the prescription for solving pipe coil problems.

PLATECOIL DIVISION, TRANTER MANUFACTURING, inc., LANSING 4, MICHIGAN

Who's Building . . .

Ind., formerly owned and operated by Johnson's, Inc. New refinery equipment will be added for the manufacture of asphalts.

McBride Will Expand Port Brownsville Plant

A $2.5 million program of plant expansion has been announced by McBride Refining Company, San Antonio, Texas. The expansion will increase the capacity of the company's Port Fuel Company plant at Port Brownsville, Texas, from 7500 barrels a day to 20,000 barrels a day. The Port Brownsville plant processes crude into gasolines, heating oils and other fuels. As part of the program the Port Brownsville refinery will get catalytic reforming facilities.

McBride has also announced that the various McBride properties, concerns and holdings will be consolidated into one general operating corporation to be known as McBride Oil and Gas Corporation.

Southwestern Pushes Unit Beyond Design Capacity

Increasing demand for catalytically-cracked products is causing Southwestern Oil & Refining Company, Corpus Christi, Texas, to push its new UOP Fluid catalytic cracking unit considerably beyond design capacity, refinery officials have announced.

The FCC unit, which went on stream recently, has a design charge of 5740 barrels a day at 50 percent conversion. Within a short time after the unit went on stream, it was charging 8170 barrels a day at 50 percent conversion, and now is running at approximately 7600 barrels a day at 58 percent conversion, with no appreciable change in octane numbers.

It was reported that when at high thruputs the refinery's new UOP gas concentration unit has maintained better than 90 percent propane recovery and 95 percent H_2S rejection.

The Fluid catalytic cracker and gas concentration unit, together with a UOP reactor type polymerization unit and treating facilities, are part of an expansion program Southwestern recently completed at its No. 2 refinery at Corpus Christi.

Bay Refining to Expand Bay City Plant Capacity

Southwestern Engineering Company has been awarded a contract to design and erect a "packaged" Thermofor catalytic cracking unit for Bay Refining Corporation of Saginaw, Mich.

The contract, amounting to approximately $3 million, calls for the development and installation of a catalytic cracking unit with a capacity of 6000 barrels a day, a catalytic polymerization unit with a 300-barrel-a-day capacity, and the necessary auxiliaries to supplement these two major units. The new facilities will be erected at Bay's refinery at Bay City, Mich., and are scheduled for completion in the fall of 1954. The

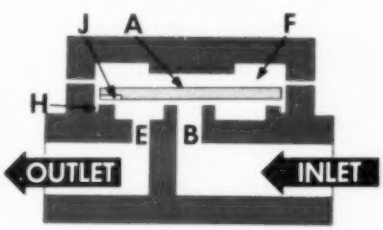
SARCO
Thermodynamic
STEAM TRAP

ACTUAL SIZE

this new trap virtually eliminates maintenance - won't wear out

SOLID STAINLESS STEEL DISC ACTS AS VALVE HEAD

HERE'S HOW IT WORKS!



Air and or condensate raise valve seat disc A, discharge thru E. When steam follows, greater velocity causes it to strike body at H thus building up pressure in chamber F. This causes disc to seat, closing tube B. As pressure in F decreases by condensation and leakage thru slot J, pressure in tube B raises disc and cycle is repeated.

The Sarco Thermodynamic Trap has proved successful on steam mains and separators; headers and soot blower pipes; engine and turbine stop valves, separators and casing drains; alternate heating and cooling applications.

A solid stainless steel disc – practically indestructible – is the only moving part!

Most striking feature of the Sarco *Thermodynamic* Trap is its simple maintenance-free design. There's only one moving part – a solid stainless steel disc that practically lasts forever. There are no other moving parts to wear out or cause trouble.

Condensate, air and steam act directly on the disc valve which opens to discharge condensate and air – snaps shut to contain steam. There are no mechanical devices required to operate valve (see diagram at left). That means practically endless trouble-free operation.

Other advantages: small size, easy installation, not affected by shock or vibration, immunity to corrosive elements with all wearing parts stainless steel, same valve head and seat for all pressures to 600 psi and temperatures to 950° F.

Check these advantages to your own satisfaction at absolutely no cost. We'll send you a trap for free trial. All you do is fill out the coupon and mail it in.

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MAIL COUPON TODAY FOR FREE TRIAL

Sarco Company, Inc., Empire State Bldg., New York 1, N.Y.
Gentlemen: Please send me a Sarco Thermodynamic Trap for free trial, requirements as checked.
Size: ½"... ¾"... 1"... Operating Pressure:.....psi

For installation on.....

NAME_____

FIRM_____

ADDRESS_____

CITY_____ STATE_____

we have never owned an oil well

Certainly oil production is indispensable to our business, nevertheless, Universal has never owned an oil well . . . . never produced any oil . . . never commercially refined, transported or marketed any petroleum products.

Our business . . . . from its very infancy . . . . has been confined to the development and commercial application of petroleum refining facilities . . . . the methods and techniques that have permitted the petroleum refiner

to produce maximum quantities of quality products to meet the demands of his markets.

That we have been successful in this effort is best evidenced by the hundreds of processing units designed by our company, and which are daily serving refineries all over the world.

Universal will never knowingly compete with a petroleum refiner in any phase of his production, refining or marketing business.

In our lifetime we could have acquired many oil wells and perhaps a refinery or two, but we've stuck to our task of helping the refiner . . . . giving him the kind of assistance that he must have if he is to realize a profitable return on his investment.

We Have Never Owned An Oil Well, is a fact that can be further emphasized by saying . . . . we never intend to. We simply won't compete with those we serve.

UNIVERSAL OIL PRODUCTS COMPANY

UOP

30 ALGONQUIN ROAD, DES PLAINES, ILL., U.S.A.

Laboratories: RIVERSIDE, ILLINOIS

Universal Service Protects Your Investment

Who's Building . . .

projected expansion of facilities will increase the Bay City refinery's crude run to 10,000 barrels a day.

Pan American Has Big Plans for Yorktown Plant

Pan American Refining Corporation's proposed 25,000-barrel-a-day refinery to be built at Yorktown, Va., may one day be as large as Pan American's Texas City, Texas, refinery.

Speaking at the dedication of Pan American's new giant 30,000-barrel-a-day fluid catalytic cracking unit at Texas City last month, James P. Patterson, vice president of Pan American Petroleum & Transport Company, the parent company, said that the proposed refinery may eventually become as large as the Texas City facilities.

Pan American Refining, an affiliate of American Oil Company, has an expansion program now under way at Texas City which includes doubling the capacity of the alkylation units and revamping the No. 3 thermal cracking unit to increase crude oil capacity and to provide additional feed stocks for catalytic cracking. Also included in the expansion are a new 21,000-barrel-a-day catalytic reforming unit which will produce high-octane gasoline components, a new research laboratory and a new office building. The Lummus Company is contractor for the new cat cracker.

Stanolind May Purchase Carthage Hydrocol Plant

An agreement has been signed by Stanolind Oil and Gas Company and the Reconstruction Finance Corporation that may lead to Stanolind's acquisition of the gas synthesis plant of Carthage Hydrocol, Inc., at Brownsville, Texas.

E. F. Bullard, Stanolind president, said the arrangement provides that Stanolind will have the opportunity to make whatever examinations and investigations it deems necessary in connection with the Carthage plant. If, on the basis of these studies, Stanolind decides that it wants to acquire the property, the arrangement signed with the RFC provides that Stanolind will acquire the stock and assume the obligations of Carthage Hydrocol, Inc. Bullard said Stanolind would begin its investigations immediately.

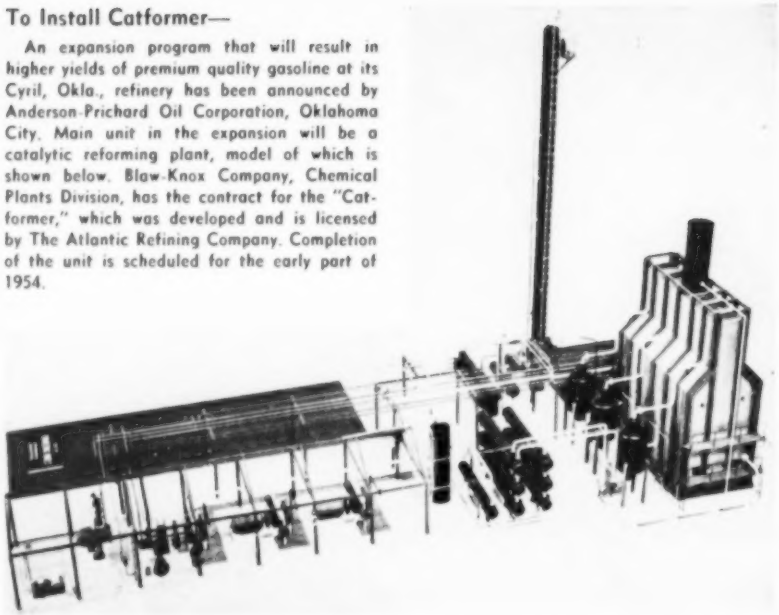
UOP Starts Work on Catalyst-Making Unit

Construction has started on Universal Oil Products Company's new UOP catalyst manufacturing plant at McCook, Ill. The new facility, the fourth for manufacturing UOP's Platforming catalyst, will cover about three acres. Consisting of two buildings, the plant will probably start production next summer.

UOP also has manufacturing facilities at Shreveport, La., London, and at the company's research and development laboratories. The processing facilities at Shreveport are to be expanded to increase capacity, with construction work expected to be complete next April.

To Install Catformer—

An expansion program that will result in higher yields of premium quality gasoline at its Cyril, Okla., refinery has been announced by Anderson-Prichard Oil Corporation, Oklahoma City. Main unit in the expansion will be a catalytic reforming plant, model of which is shown below. Blaw-Knox Company, Chemical Plants Division, has the contract for the "Catformer," which was developed and is licensed by The Atlantic Refining Company. Completion of the unit is scheduled for the early part of 1954.



Texaco Gets Top ODM Tax Write-Off

The Texas Company has received rapid tax write-off certificates totaling $11,653,100 on its planned addition of refining facilities at Lawrenceville, Ill., and storage facilities at Mt. Vernon, Ind., to head the latest list of petroleum projects approved for fast tax write-off by the Office of Defense Mobilization. Included in the additional refining facilities to be built at Lawrenceville is a 2253-barrel-a-day alkylation unit. Texaco's grant breaks down into: 100 percent write-off rate on $3,719,600 for the alkylation unit; 65 percent on $5,673,300 for basic refining facilities, and 45 percent on $2,260,200.

Gulf Oil Corporation was second, receiving write-offs totaling $5,787,000 for its refining project at Toledo, Ohio. Approval was given for a 10,000-barrel-a-day platformer and auxiliary facilities to produce high-octane gasoline at Toledo. Gulf was granted $4,878,687 certified at 65 percent; $797,466 at 45 percent, and $110,847 at 15 percent.

Other projects approved for fast write-off, showing company, location, facility involved, total cost approved, and percentage of that cost certified, were as follows:

California Oil Company—Perth Amboy, N. J., increased recycling capacity of cat cracker to permit upgrading of 1300 barrels a day of heavy fuel into gasolines and heating oils, and installation of 10,000-barrel butane storage sphere for increased feed stock for alkylation unit at Perth Amboy refinery, $1,635,000: $15,000 at 90 percent; $1,485,000 at 65 percent.

Petrolite Corporation—Wilmington, Del., installation of electric desalting plant to remove salt from 16,000 barrels of crude oil at The Texas Company refinery, Amarillo, Texas, $38,517 at 65 percent.

Petrolite Corporation—Wilmington, Del., installation of electric desalting plant to remove salt from 33,000 barrels of crude oil at Standard Oil Company (Indiana) refinery, Mandan, N. Dak., $47,917 at 65 percent.

The Texas Company—New York, catalytic polymerization unit at Sunburst, Mont., refinery to convert waste gases into 85 barrels a day of polymer for blending into gasoline, $293,600: $274,600 at 65 percent; $19,000 at 40 percent.

Woodlawn Process Corporation—Harrison County, Texas, natural gas extraction plant, and 30-mile delivery pipe line to Panola County, Texas, $1,617,500: $1,325,000 at 65 percent; $292,500 at 25 percent.

Reef Fields Gasoline Corporation—Howard County, Texas, gasoline plant facilities to recover 17,500 gallons of iso-butane daily for use in alkylation, $274,830: $260,705 at 100 percent; $14,125 at 65 percent.

American Cyanamid Company—Willow Island, W. Va., facilities to produce catalyst, $1,500,000: $1,265,000 at 65 percent; $235,000 at 50 percent.

Hancock Oil Company—Long Beach, Calif., 2500-barrel-a-day catalytic reforming unit to produce blending stocks for high-octane gasoline, $549,190: $535,270 at 65 percent; $13,920 at 50 percent.

Mohawk Petroleum Corporation—Bakersfield, Calif., unit to reform 2500 barrels a day of naphtha to use in high-octane gasoline, $691,000: $668,140 at 65 percent; $22,860 at 50 percent.

Continental Sulphur Will Build New 50-Ton Plant

American Sulphur & Refining Company has licensed Continental Sulphur & Phosphate Corporation to use a new sulfur extracting process for the construction of a 50-ton initial plant at Thermopolis, Wyo. Production of the Continental sulfur plant is expected eventually to reach 200 to 300 tons a day with the addition of new plants. The initial plant is scheduled to begin

LDB101 NL PD= HOUSTON TEXAS 20 11:37A=
JOHN SMITH BROWN & ROOT, INC.
PITTSBURGH , PA.
JOB 2283 AHEAD OF SCHEDULE.
PLEASE EXPEDITE VESSEL NO. T47.
ADVISE SHIPPING DATE.
DYESS, SUPT.

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In every major fabrication center of the United States, BROWN & ROOT maintains highly trained experts in procurement and expediting. They know where materials and equipment are, and how to get them to a BROWN & ROOT project *fast.*

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Announcing Foster Wheeler's new

completely tooled to effectively meet your most exacting needs for steam generators, heat-transfer and process equipment!

1. 8000 TON BEAM PRESS
Hydraulically operated, will bend steel plates 40′ long, 8″ thick.

2. PLATE EDGE PLANER
Will take the longest available plates, for cutting welding grooves.

3. OVERHEAD CRANES
Four large cranes capable of lifting the heaviest and largest equipment easily.

4. DOUBLE HOUSING PLANER
Highest speed planing.

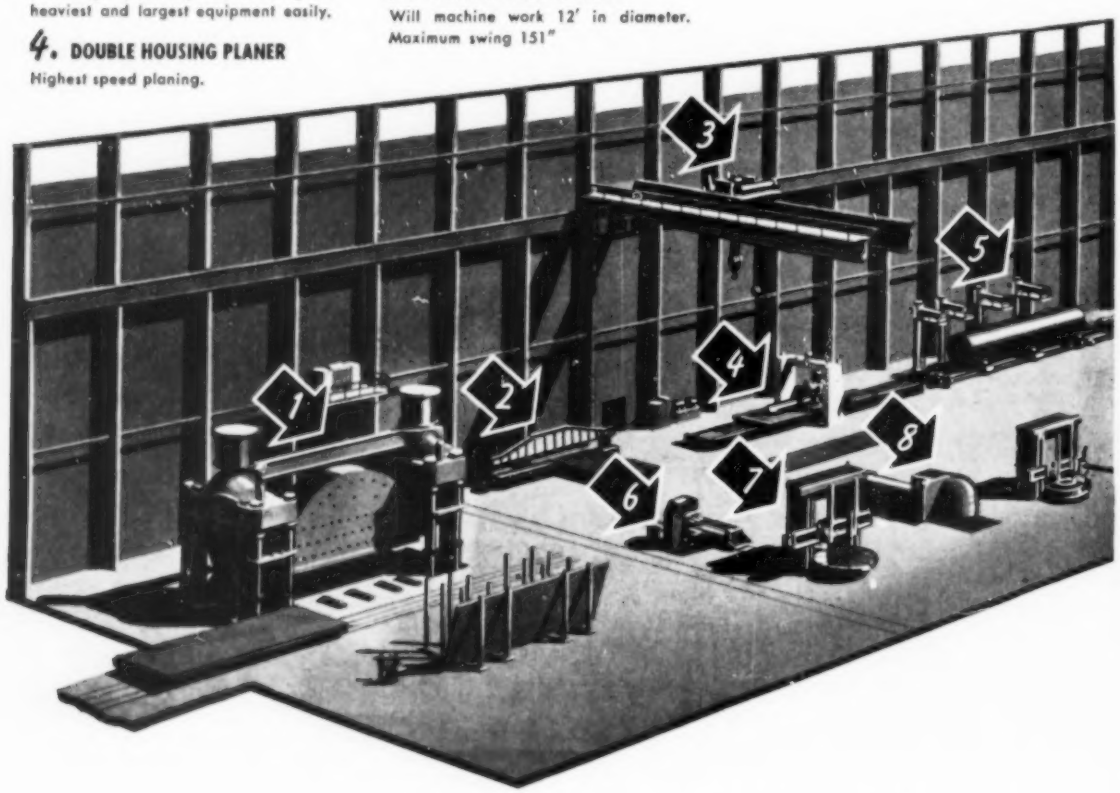
5. AUTOMATIC WELDING MACHINES
Submerged-arc, automatic flux recovery-type, mounted on track.

6. 500 TON CRIMPING PRESS
For cold-bending edge of plate preparatory to rolling.

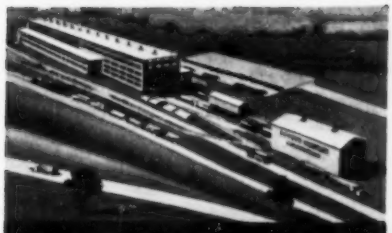
7. VERTICAL BORING MILL
Will machine work 12′ in diameter. Maximum swing 151″

8. BENDING ROLLS—PINCH TYPE
By hot or cold rolling will form cylinders for medium-pressure vessels.

9. HIGHEST SPEED DRILLS—RADIAL TYPE
These are mounted on ways and tracks, power positioned.



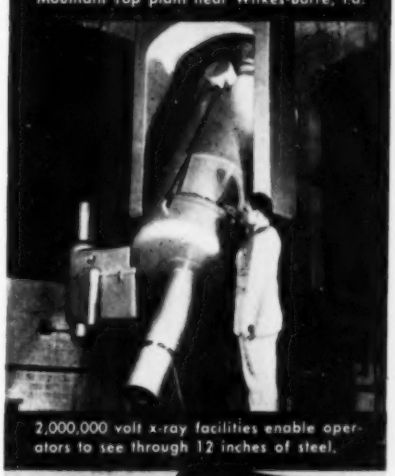
Mountain Top plant...



Artist's drawing of Foster Wheeler's new Mountain Top plant near Wilkes-Barre, Pa.

ANTICIPATING your requirements for more efficient central station, industrial and process components, Foster Wheeler has installed in this new plant, near Wilkes-Barre, Pa., the latest, most modern equipment, such as: the 8000-ton beam press, 2 million volt x-ray facilities, the newest developments in submerged arc-welding and high-speed drilling equipment, 83½ foot long stress-relieving furnace and others shown here.

This modern equipment, plus the plant's proximity to steel supplies, and its strategic location for direct rail shipment to all areas of the country, assure you of fast, economical, high-quality fabrication to meet your specifications for the largest and heaviest drums and pressure vessels.

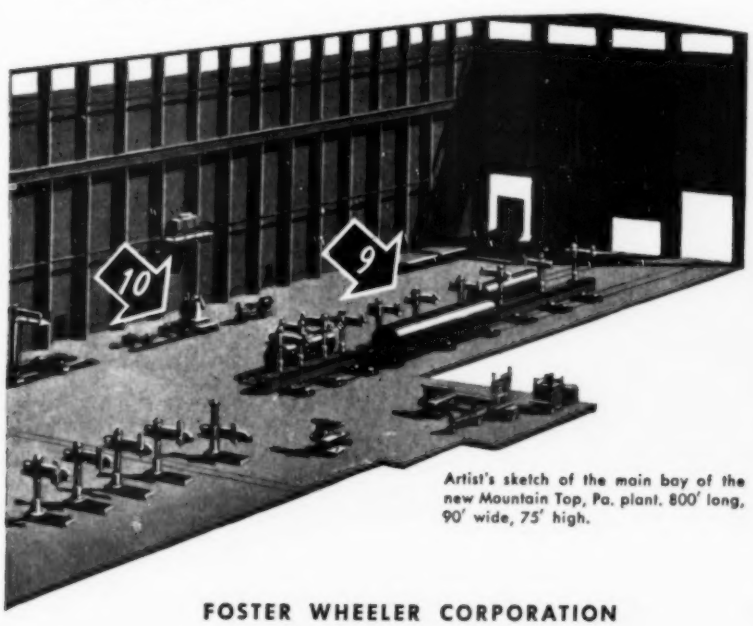


2,000,000 volt x-ray facilities enable operators to see through 12 inches of steel.

10. **DRUM FACING MACHINE**

Quick preparation of ends of cylinder for assembly with heads.

Stress relieving furnace permits annealing of fabricated parts more than 83 ft. long.



Artist's sketch of the main bay of the new Mountain Top, Pa. plant. 800' long, 90' wide, 75' high.

Shot blast building is equipped for surface cleaning by latest practice.

Plate normalizing furnace will take the largest available plates for preheating prior to bending or rolling.

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Designers and Constructors of

Stationary and Marine Steam Generators and Condensers
Process Equipment • Chemical and Petroleum Plants

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Why You Should Use... PAGE Automatic Welding Wire

• PAGE Automatic Welding Wire is made to rigid specifications which provide consistent characteristics for smooth flow of metal during continuous or intermittent welding. There are many analyses for a wide variety of uses.

for INERT GAS Welding

PAGE Stainless Steel Wire is precision thread-wound on 25-lb. non-returnable convenient reels which fit popular arc welding machines. Six Page-Allegheny grades; wire diameters: .035", .045", .0625".

for SUBMERGED ARC Welding

PAGE stainless, low alloy, and carbon steel wire in layer-wound coils, in 22" or 24" mill coils, or on 200-lb. returnable steel reels. Wire diameters from 1/32" to 5/16"; copper coated if desired.

ACCO

Write to our Monessen, Pennsylvania office for Bulletin DH-402

PAGE STEEL AND WIRE DIVISION
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Monessen, Pa., Atlanta, Chicago, Denver, Detroit, Los Angeles, New York, Philadelphia, Portland, San Francisco, Bridgeport, Conn.

PAGE Welding Electrodes AND Rods

Who's Building...

production of granulated, 99.6 percent pure sulfur within six or eight months.

Petroleos Mexicanos Lets Contract For Cat Cracker

Contract for the modernization and expansion of Petroleos Mexicanos' Minatitlan refinery has been let to The Fluor Corporation, Ltd. The contracted work consists of a topping unit, feed preparation, fractionation, gas concentration, polymerization unit, offsite facilities, and the first cat cracking unit to be installed by Petroleos Mexicanos.

Construction Capsules

Brea Chemicals, Inc., expects to construct a sulfur production plant at Rodeo, Calif. Its present plans include piping of waste products from Union Oil Company of California's refinery at Oleum, Calif., and converting them to elemental sulfur. Applications for building permits have been submitted.

•

Great Southern Chemical Corporation planned to get into production of benzene and toluene at its Corpus Christi, Texas, plant by early last month. Being constructed by The Fluor Corporation, Ltd., and Procon, Inc., the plant will produce benzene, toluene and chemical specialties.

•

Anderson-Prichard Oil Corporation has awarded Blaw-Knox Company a contract for the construction of 1000-barrel-a-day catformer at its Cyril, Okla., refinery. The unit will be licensed by The Atlantic Refining Company.

•

Anglo-Canadian Oil, Ltd., has awarded a contract for the rehabilitation of its refinery at Brandon, Man., Canada, which was damaged by fire October 10, to Refinery Engineering, Ltd., an affiliate of Refinery Engineering Company of Tulsa. Primary damage to the plant was estimated at approximately $250,000.

•

Standard Sulfur Company has begun operation of a new sulfur extracting plant at Damon Mound in Brazoria County, Texas. The plant is expected to produce between 200 and 250 tons daily.

•

Taylor Oil & Gas Company has put on stream a new 5000-barrel-a-day platformer at its Corpus Christi, Texas, refinery.

•

Shell Oil Company has awarded a contract for the construction of its 50,000-barrel-a-day refinery at Anacortes, Wash., to Bechtel Corporation.

•

Ben Franklin Refining Company has put a 5000-barrel-a-day fluid catalytic cracking unit on stream at Ardmore, Okla.

•

Union Oil Company of California is planning to construct its proposed coking plant near San Luis Obispo and Santa Barbara, Calif. The project is part of a $40 million expansion program being carried on by the company.

•

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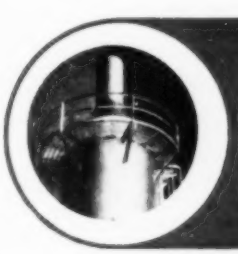

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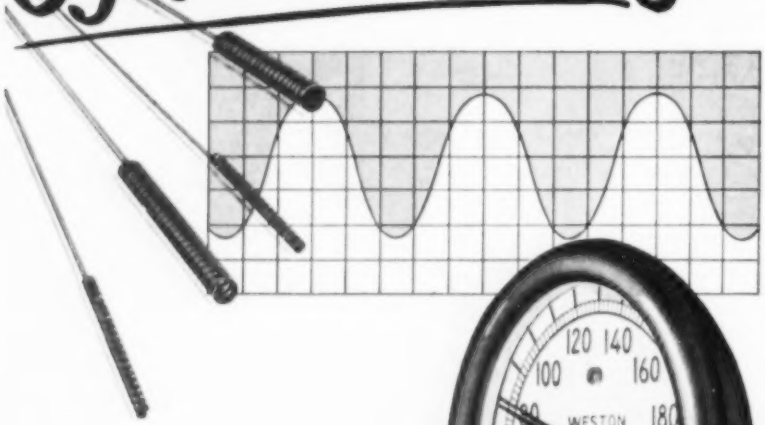

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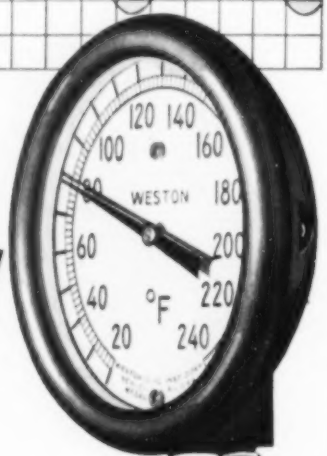

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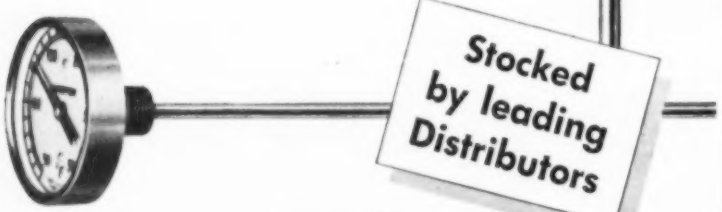

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Who's Building . . .

a 1000-barrel-a-day Houdriformer at its Irving plant located near Dallas, Texas. The new unit is designed for a considerable degree of flexibility required for its projected use in petrochemical service and high-octane fuels. Tears Engineering of Dallas will handle the engineering and construction of the reformer, with completion scheduled for mid-1954.

•

Texaco Oil Company has started work on a new $6 million gas absorption plant at Pigeon Lake, 40 miles southwest of Edmonton, Canada. A 67-acre site approved by the Alberta Petroleum and Natural Gas Conservation Board has been cleared, and preliminary construction work has started. When completed, the plant will process natural gas from Bonnie Glen and Wizard Lake. Petroleum and by-products will be extracted from natural gas.

•

N. V. de Bataafsche Petroleum Maatachappij, a member of the Royal Dutch Shell Group of companies, has started operation of a 65,700-barrel-a-day crude distillation unit at its Pernis refinery near Rotterdam, making the refinery the largest in Europe including Britain. Crude capacity has been boosted to 165,700 barrels a day from 100,000 barrels a day.

•

Belge des Petroles, joint subsidiary of Petrofina and Anglo-Iranian Oil Company, will add a 10,000-barrel-a-day catalytic cracking unit and catalytic polymerization unit to its Antwerp, Belgium, refinery. Work on these additions has begun and will be finished by the end of 1954, or early in 1955.

•

The Egyptian government is expected to ask shortly for bids for building a pipe line from Suez to Cairo to feed a new refinery to be built near Cairo. According to the National Production Council, the refinery will have an ultimate capacity of 20,000 barrels a day.

•

Shell Oil Company of Canada is planning the second expansion in two years for its Jumping Pound gas processing plant, which is 20 miles west of Calgary. New extensions will increase handling capacity to 70 Mmcf a day, almost tripling the original capacity of 25 Mmcf. The plant expansion contract has been awarded to Refinery Engineering, Ltd., Toronto.

•

First National Petroleum Corporation plans to double the capacity of the refinery which it recently purchased for "somewhat less" than $250,000. The refinery, at Jensen, Utah, was owned by Utah Cooperative Association. The planned expansion will boost the capacity of the refinery to 3000 barrels a day. A $1,250,000 cracking unit will also be constructed.

•

Houdry Process Corporation, Philadelphia, Pa., and **Canadian Petrofina Ltd.** have concluded arrangements for a Houdriflow catalytic cracking unit to be constructed at Canadian Petrofina's new Montreal, Quebec, Canada, refinery. Designed for a nominal total feed capacity of 20,000 barrels a day, the catalytic unit will be one of the major units in the new 20,000-barrel-a-day refinery.

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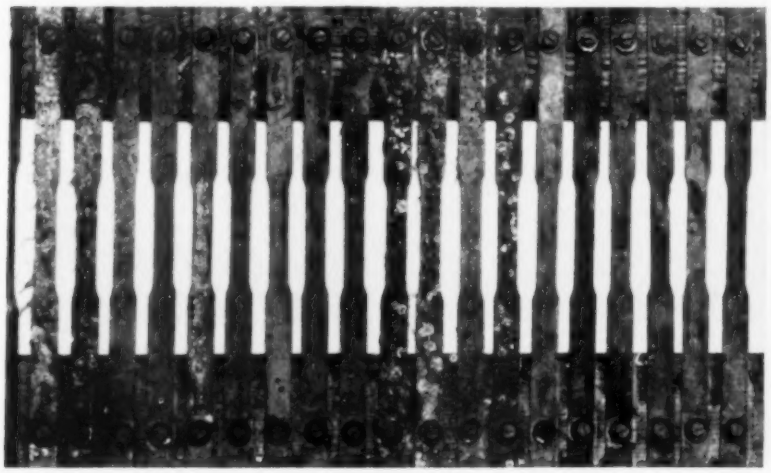

How various copper alloys respond toward biofouling in harbor water. The most corrosion resistant are the most affected by biofouling because of their solubility in sea water. This makes them less toxic to marine organisms, because their surfaces do not have a sufficient concentration of copper salts.

Good Cleaning Practices Increase Efficiency and Life of Tubes

The accumulation of foreign matter, such as slime, biofouling organisms, silt, cinders, and trash, lodging in condenser tubes, affect heat transfer and may lead to accelerated corrosion.

The problem of cleaning condenser and heat exchanger tubes and keeping them clean varies considerably from one plant to another.

In some plants rubber plugs have been found very satisfactory. The proper type and size depend upon the character of the silt or film to be removed. Rubber plugs, brushes, or scrapers usually are shot through the tubes by compressed air and water. The dumbbell type plug which has two wiping surfaces is quite popular.

Occasionally the cleaning implements are stopped by debris which may require "rodding." The best way to prevent debris from entering the tubes is by the proper use of strainers and screens.

Obstinate scales can often be dissolved by either inhibited acids or strong alkaline solutions which do not attack the tube itself. Chemical cleaning will be discussed in detail in a future Copper Alloy Bulletin.

Chlorination for Slime Prevention

A properly set up schedule of chlorination is very satisfactory for slime prevention. The chlorine concentration required varies with the character of the water. Over-chlorination should be avoided as it may injure the protective film and lead to accelerated corrosion. Generally, a red-brown or amber-colored film forms on the tube surface when the chlorination practice is satisfactory. This type of film is repeatedly found on tubes giving excellent results.

Excessive Chlorination Harmful

The resistance to corrosion from chlorinated waters varies with the alloy. Arsenical Admiralty (copper 70%, tin 1%, arsenic 0.03%, zinc remainder) and Muntz (copper 62%, zinc remainder) are not affected by mild chlorine solutions but may be severely attacked by strong ones. Aluminum Brass (copper 77%, aluminum 2%, arsenic 0.02%, zinc remainder) and Duronze IV, Aluminum Bronze (copper 94.25%, aluminum 5.5%, arsenic 0.25%) and the Cupro Nickel alloys are more resistant to chlorine solutions than the previously mentioned condenser tube alloys.

Biofouling Versus Corrosion Resistance

Biofouling of condenser tubes is associated with slowly moving sea water. In general, biofouling increases with the decrease in corrosion rate. Consequently, the high corrosion resisting alloys such as 70-30 Cupro Nickel (containing approximately 0.5% iron), Aluminum Brass and Durozone IV are highly susceptible to biofouling because of their low rates of solubility in sea water. The water film adjacent to the metal surface does not contain a sufficient concentration of copper salts to be toxic to marine organisms. Admiralty, Muntz, and Copper resist biofouling because of their higher solubility in sea water.

Biofouling organisms should be promptly removed from the tube surface by scrubbing with a stiff fiber brush and water. If the organisms are allowed to die and dry on the surface, considerable difficulty is experienced in removing those with calcareous bases such as barnacles. When not removed, such organisms and their decomposition products destroy the corrosion film and act as focal points for corrosion pitting. Decomposed organisms can lead to the formation of ammonia which may be followed by stress corrosion cracking of copper alloys with high zinc content.

Operation at a water velocity high enough to prevent organisms from attaching themselves is often helpful.

Technical Service Available

If you are contemplating retubing or are planning for new installations of condenser or heat exchanger tubing, consult the nearest Bridgeport sales office for technical help in selecting the alloy which will serve best for your particular operating conditions. Write on Company stationery for a copy of the 156-page Condenser and Heat Exchanger Tube Handbook. (965)

Here's More

Information on Advertised Products

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Refractories Manual

The Refractories Division of Norton Company has released a new instructive manual entitled, "Norton Refractories for Heat and Power." This 32-page booklet is designed to help in the selection of the proper refractory products for critical areas in boilers, stills, and etc. It contains detailed information on the characteristics of refractories; and data on products for air-cooled wall protection, solid wall protection, water tube protection, brick laying, and general repairs. Helpful suggestions on the use of refractories for many different applications, as well as engineering tables and curves on the thermal conductivity and thermal expansion of various refractories, are included. For your copy of this informative bulletin, simply . . .

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High Temperature Alloys

The H. M. Harper Company has just issued an informative bulletin on high temperature alloys such as Refractaloy, Discaloy, Inconel, Hastelloy alloys, A-286, and etc., with a special section on Titanium. This 12-page bulletin contains data on these alloys, together with a section on the characteristics of high temperature bolting. Tables give mechanical properties and chemical composition of the various alloys and illustrate many types of fastenings produced from these alloys as well as Titanium.

Circle No. 2 on Postcard

Process Control Problems

Wheelco Instrument Division of Barber-Colman Company is now offering a new data book to those interested in solving process control problems. Known as TC10, this 42-page Data Book and Catalog shows a complete line of thermocouples, radiation detectors, and resistance bulbs. Information on various sensing units, protection tubes, and lead wires, as well as tips on instrument servicing, is included. For your free copy of this helpful data book and catalog, just . . .

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Gas Controls

Hoke Inc., is making available a new 66-page catalog and engineering data book describing the complete line of Hoke small valves, high vacuum valves, pressure regulators, high pressure cylinders, oxy-gas torches, and other gas control devices. The large data section includes much information on such items as pressure drops, materials of construction, thread identification, and connection techniques. For this informative book which should be in your files just...

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What's New in Manufacturers' Literature

Use one of the free and convenient Reader Service Postcards on this page to request copies of the catalogs in which you are interested.

Steel Characteristics

The International Nickel Company has made available two new bulletins. The first is a 48-page booklet prepared for the Metals Division, Special Libraries Association. This booklet lists chronologically 468 magazine articles, translations, pamphlets, and books on the characteristics of steels at low temperatures. The second is a 14-page study, with charts and graphs, of sigma formation and its effects. The brittle, metallic compound discussed in the bulletin has been found likely to occur in high chrome ferrous alloys. As little as 5 percent may cause serious embrittlement. These bulletins should be of interest to all engineers in the refining and petrochemical industry.

Circle No. 5 on Postcard

Catalyst Testing

American Cyanamid Company's Refinery Chemicals department has published a 48-page booklet, "Test Methods for Synthetic Cracking Catalysts." The booklet describes a group of standardized testing procedures for measuring some important properties of silica-alumina synthetic fluid catalysts. Among these procedures are: determination of apparent bulk density, activity, steam stability, thermal stability, particle size distribution, surface area and pore volume, resistance to attrition, methods of analysis for chemical constituents and impurities, and shipment sampling.

Circle No. 6 on Postcard

Pipe Ratings

The Pipe Fabrication Institute has just issued a new technical bulletin containing more than 5000 pressure temperature ratings of the various grades of pipe in common use in industry. These ratings have been calculated by recently revised formulas and allowable stress values applying to the ASA Code for pressure piping and the ASME Power Boiler Code. Arranged for easy reference, the ratings will eliminate the tedious calculations previously necessary, and will save much time both in preliminary studies and in final design. This bulletin, TB1-1953, is available without cost. Just . . .

Circle No. 7 on Postcard

TEL Analysis

A new booklet by Fisher Scientific Company gives the "ABCs" of the theory and operation of the recently announced Fisher TEL Meter. This instrument is claimed by the company to be the "first direct-reading pushbutton instrument for assaying tetraethyllead in gasoline." For your copy of this bulletin, just . . .

Circle No. 8 on Postcard

Silicones

Dow Corning has issued a new 1953-1954 reference guide to silicone products. With the addition of 15 new products, this year's guide is said to be the most thorough and comprehensive listing of silicone products ever published. For your copy of this guide and its complete information on these new and versatile compounds, just . . .

Circle No. 9 on Postcard

Cathodic Protection

The Cathodic Protection Service Company has published a new catalog containing some 75 pages and listing over 700 different items used by cathodic protection and corrosion control engineers. Known as Catalog No. 54, this book also contains a technical data section which should prove invaluable to those engaged in this field.

Circle No. 10 on Postcard

PETROLEUM REFINER Reader Service Postcard—Dec., 1953, Issue*

EDITORIAL ITEMS—Circle item numbers on which more information desired:

1	4	7	10	13	16	19	22	
2	5	8	11	14	17	20	23	
3	6	9	12	15	18	21	24	

ADVERTISEMENTS—Circle key number of ad for more product information:

A1	B1	C1	D1	E1	F1	G1	H1	J1	K1	L1	M1	N1	P1	Q1	R1	S1
A2	B2	C2	D2	E2	F2	G2	H2	J2	K2	L2	M2	N2	P2	Q2	R2	S2
A3	B3	C3	D3	E3	F3	G3	H3	J3	K3	L3	M3	N3	P3	Q3	R3	S3
A4	B4	C4	D4	E4	F4	G4	H4	J4	K4	L4	M4	N4	P4	Q4	R4	S4
A5	B5	C5	D5	E5	F5	G5	H5	J5	K5	L5	M5	N5	P5	Q5	R5	S5
A6	B6	C6	D6	E6	F6	G6	H6	J6	K6	L6	M6	N6	P6	Q6	R6	S6
A7	B7	C7	D7	E7	F7	G7	H7	J7	K7	L7	M7	N7	P7	Q7	R7	S7
A8	B8	C8	D8	E8	F8	G8	H8	J8	K8	L8	M8	N8	P8	Q8	R8	S8
A9	B9	C9	D9	E9	F9	G9	H9	J9	K9	L9	M9	N9	P9	Q9	R9	S9
A10	B10	C10	D10	E10	F10	G10	H10	J10	K10	L10	M10	N10	P10	Q10	R10	S10

Name (Please Print)_____

Company_____ Position_____

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REFINER

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To Get
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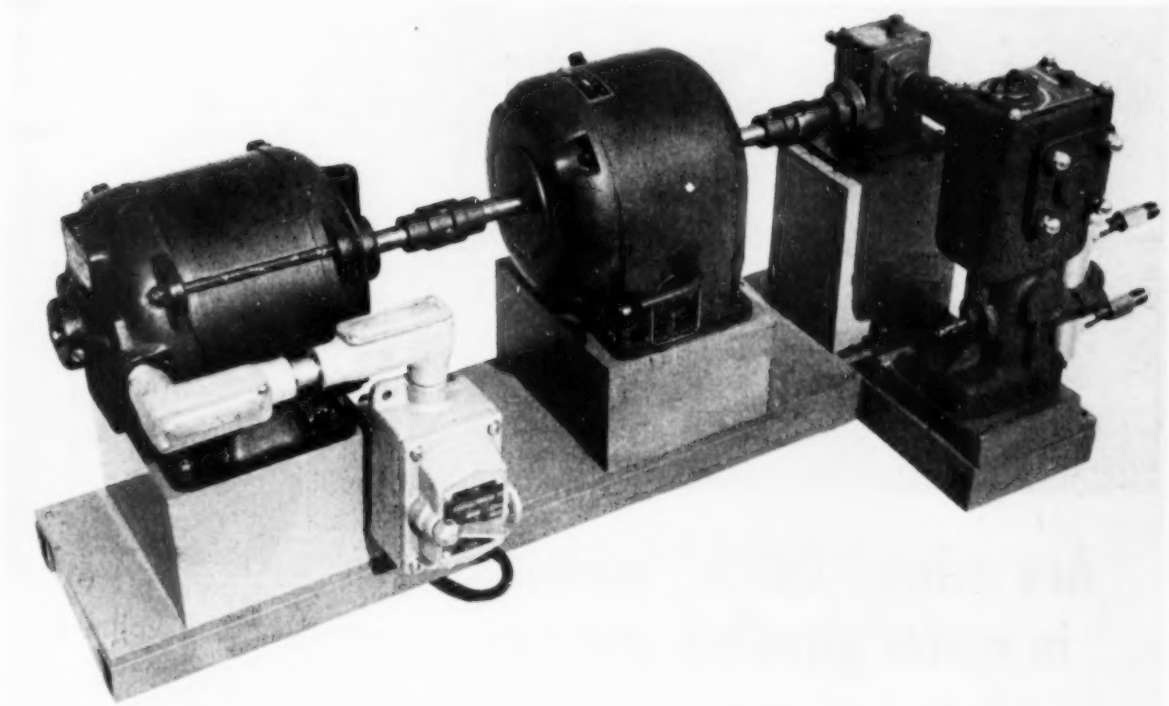
And for More
Information on
NEW EQUIPMENT
ADVERTISED PRODUCTS

What's New In Equipment . . .



Proportioning Pump

A new metering and proportioning pump, known as the "A Series," has been developed by Precision Pump Company for the pumping and metering of such materials as light liquid hydrocarbons, water, and liquefied petroleum gases. The units have been specifically designed to accurately meter at high pressures, and over a wide output flow range.

The pumps are fully enclosed, light alloy units of the positive displacement type. Virtually all parts that come in contact with the liquid being pumped are made of type 18-8 stainless steel, the only exception being valves and valve seats, which must be made from alloys that can be hardened. The pumping element is sealed—absolutely leak proof—and contains no packing glands or stuffing boxes. Any desired flow rate, from zero to full pump capacity, can be attained while the pump is stationary, or while running, by light finger pressure on the output control lever, which may be easily locked.

The Laboratory Model is an extremely versatile unit. It consists of an electric motor (which may be of any type to meet customer's electrical requirements), suitable speed reduction including a 4-speed transmission, and the Precision "A Series" pumping element. Any of the four speed ratios of the gear-box may be selected by moving the gear ratio selector lever, which operates very similarly to an automotive type mechanical transmission. A fifth position of the lever puts the unit in neutral, which permits stopping of the pumping element without turning off the electric motor. This feature is often very convenient, especially in duplex pump operations. Two separate and independent methods for control of the pump flow rate are thus available. The number of pump strokes may be varied by use of the gear ratio selector, and the quantity per pump stroke may be varied by means of the pump output control lever. Flow rates from 25 cc. to 12 gallons per hour are possible with a single Simplex Model.

Single-Speed Models are also available for both laboratory and pilot plant pumping applications where such a wide flow rate range is not required. Pump output may still be controlled, of course, by the pump output control lever. These units are also available in Simplex and Duplex Models, and can be custom-tailored to customer's specifications to insure maximum accuracy of metering and control requirements.

All standard "A Series" pumping elements are suitable for maximum discharge pressures up to 2500 psig. High pressure units are also available with maximum discharge pressures up to 5000 psig.

Another outstanding feature of the Precision pump is the valve assembly. The novel valves utilized with this pump are the result of many years of intense basic research and development. They are a flat-type, having flat mating valve and valve seat surfaces. The valves are light, fast acting, positive seating, and incorporate a self-cleaning feature which makes them especially suited for difficult pumping problems.

Precision valves are hardened, ground, and lapped to the most rigid manufacturing specifications.

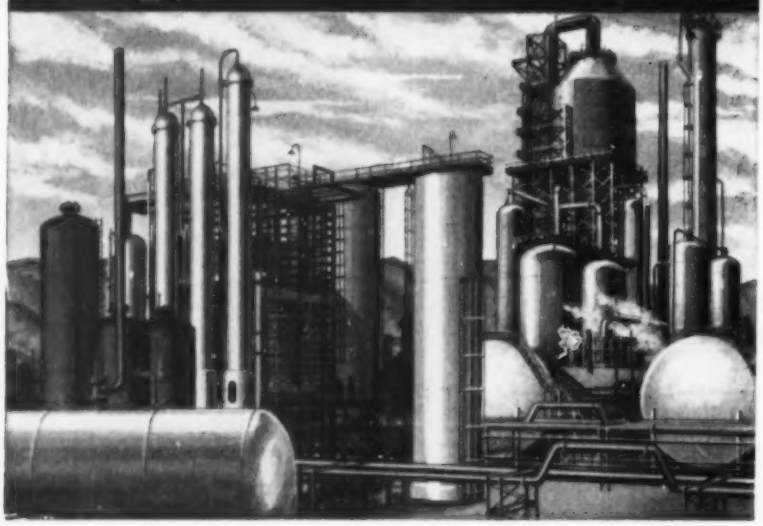
Circle No. 11 on Postcard

Single Unit Annunciator

The SCAM Instrument corporation is introducing its DE line of ACS-C1 annunciators. Designed for use in graphic panels, the ACS-C1 requires but a fraction of the panel space commonly needed. Its cost is commensurately less. Among the features of the ACS-C1 are:

- It can be used with either N O or N C field signals.
- It is self monitoring, signals its own

Why REFINERIES-



Are using "DBPC" inhibitor in motor gasoline storage

IF you are interested in getting the best and most economical protection against oxidation of motor gasoline in storage, "DBPC" inhibitor (di-tertiary-Butyl-para-Cresol) is worth your serious consideration.

Several large American refineries are now using this Koppers oxidation inhibitor under actual gasoline storage conditions, and have found that:

- **"DBPC" is more economical on a pound per barrel basis than any other gasoline antioxidant.**
- "DBPC" prevents the formation of gum in motor gasoline over storage periods of six months.
- It can be added early in the refining process when the gasoline is most susceptible to inhibitor addition.
- Once added, "DBPC" cannot be extracted from the gasoline by water, caustic, clay, or the commonly-used pipe line corrosion inhibitors.
- "DBPC" antioxidant will not impart color to motor gasoline.
- "DBPC" is safe to handle. It is non-irritating and practically non-toxic under normal handling conditions.

For more details about "DBPC"—either in flake or solution form, write to Koppers today.

KOPPERS COMPANY, INC.
Chemical Division, Dept. PR-123, Pittsburgh 19, Pennsylvania

KOPPERS® **Koppers Chemicals**

New Equipment . . .

failure.
- "Ring-back" sequences are available.
- Each unit has a positive ground.
- Units are completely interchangeable.
- Each unit has a "Lock-in" momentary alarm.

To get the information you need for your application, just . . .

Circle No. 12 on Postcard

Vacuum Tube Voltmeter

Southwestern Industrial Electronics Company is making available a new laboratory VTVM. Known as Model R-1, it is an extremely versatile instrument which will take the place of several different pieces of equipment now in general use. Some of the outstanding features of this new instrument are:

- Distended d.c. volt range; bucks out up to 99 percent of measured voltage and indicates remaining voltage full scale.
- d.c. millivolt ranges from 1 mv. to 1000 mv.
- a.c. volt and millivolt ranges from 1 mv. to 1000 volts. Frequency ranges from ten cps. to 100 kc.
- Self contained standard cell for rapid and accurate calibration.
- Ohms ranges from times 1 to times 10^6.
- Output terminals which allow the use of the instrument as a d.c. amplifier, as well as the attachment of a recorder on all scales.

Research and instrument personnel should find the answers to many of their electronic measurement problems in the R-1. For complete specifications on this new instrument, just . . .

Circle No. 13 on Postcard

Adhesive for Teflon

The Flexrock Company is now offering an adhesive for binding Teflon to Teflon, or Teflon to metal and a variety of other materials. Some of the features included in this newly developed pressure sensitive adhesive are:

- Peel strength of over 1000 gms. per

YOU GET MORE!

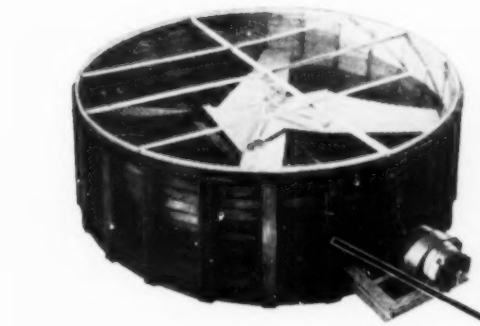
There are many reasons why you get more from Pritchard Heavy-Duty Cooling Towers. One of these is the exclusive patented features incorporated into Pritchard advanced cooling tower design.

Features like the POWAIRSAVER* fan—the first fan exclusively designed, built, rated and tested on an induced draft cooling tower for cooling tower service. These lightweight fans are designed for longer life with corrosion-resistant stressed skin blade surfaces, made of monel metal or stainless steel depending upon your specific service requirements. These patented fans are designed to operate with high aero-dynamic efficiency at low horsepower—your key to top cooling tower performance.

Over the years, leaders in the petro-chemical industry have learned *all* the reasons why Pritchard cooling towers give them more. If *you* want more efficiency . . . more years of dependable performance . . . from your next cooling tower, be sure to consult Pritchard—a founder member of the Cooling Tower Institute.

**Registered Trade Name*

Industry's Partner for Progress



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ENGINEERS • CONSTRUCTORS • MANUFACTURERS
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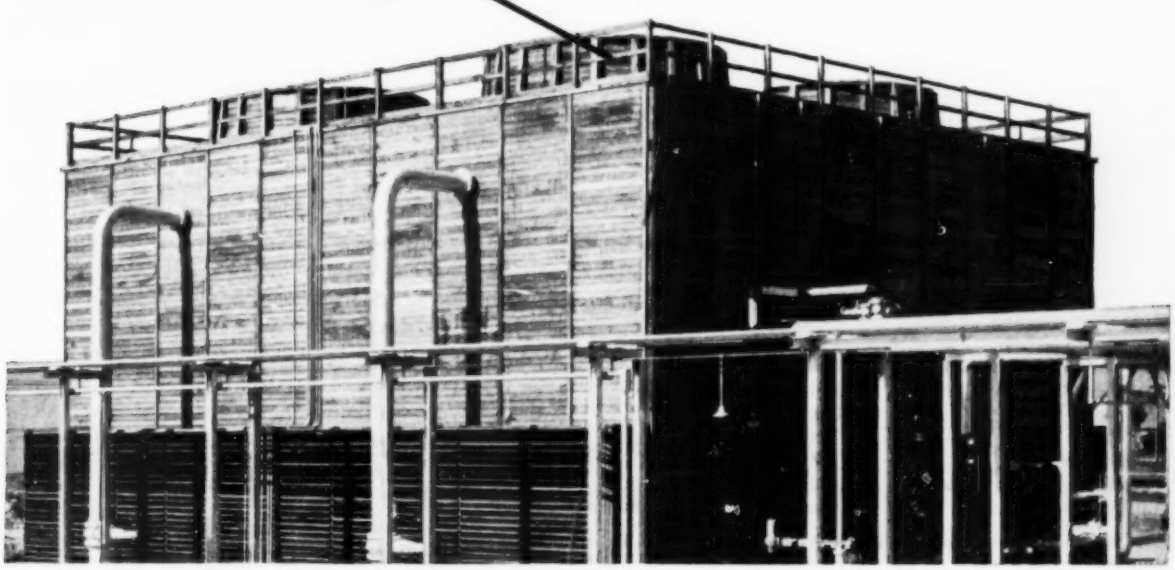
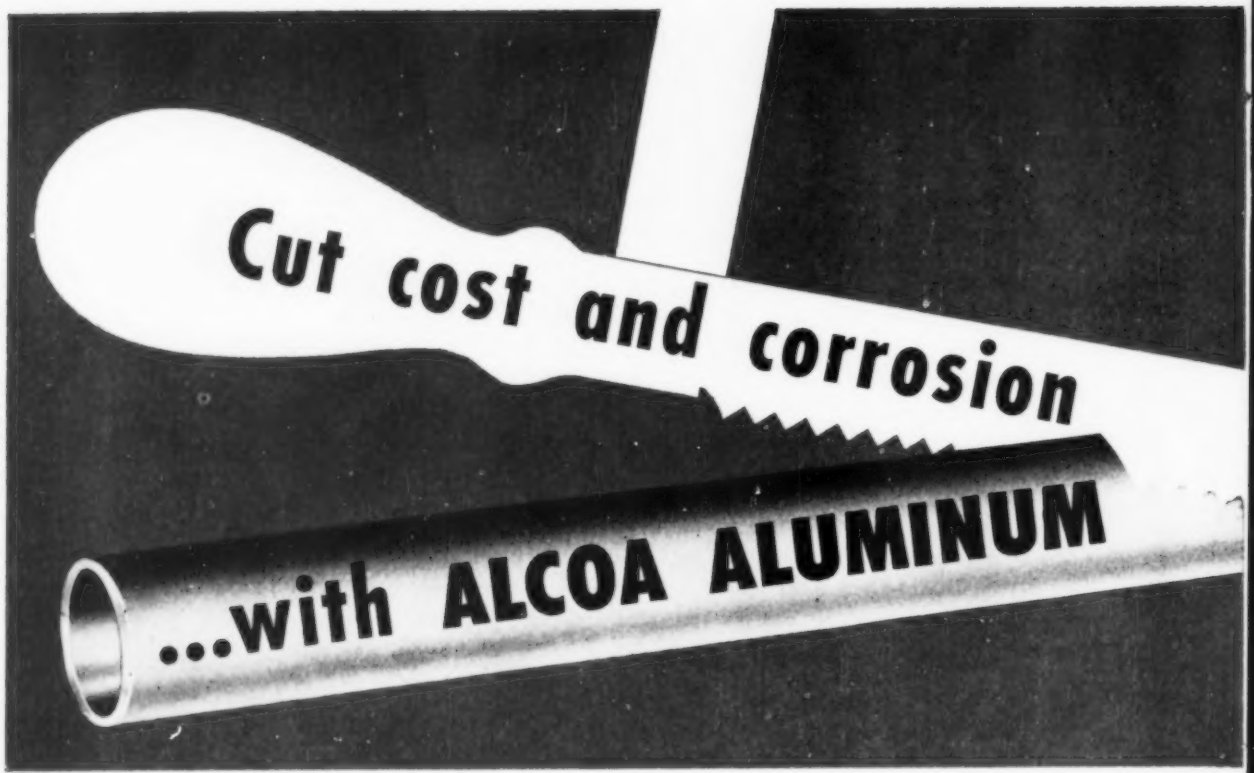




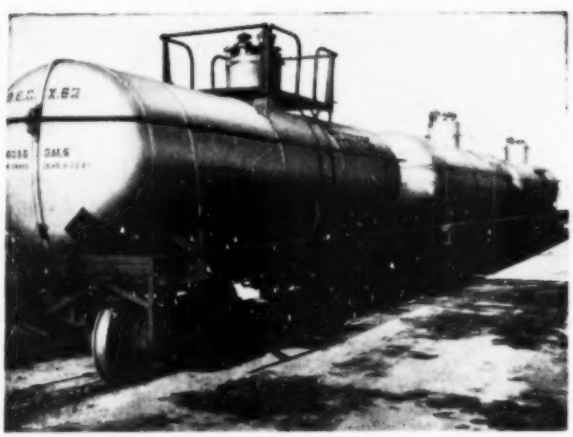
Having trouble with shipping these products?

It's time to consider tank cars of aluminum.

Acetaldehyde
Acetic Acid
Acetone
Acrylonitrile
Ammonia, Aqua
Ammoniacal Liquor
Ammonium Thioglycolate solution
Amyl Acetate
Benzaldehyde
Benzene (Benzol)
Benzyl Alcohol
Butyl Acetate
Butyl Alcohol
Butyric Acid
Butyric Anhydride
Carbon Bisulfide
Corn Syrup
Cottonseed Oil
Ethyl Alcohol
Ethyl Aniline
Ethylene Glycol
Ethylene Glycol Monoethyl Ether Acetate
Formaldehyde
Furfural
Glucose Syrup
Glycerin
Glyceryl Phosphate
Hydrogen Peroxide
Inks, Rotogravure
Lacquers
Methyl Alcohol
Naphtha
Nitric Acid (above 82% concen.)
Nitrogen fertilizer solutions
Nitro Paraffins
Oil
- Castor
- Coconut
- Cottonseed
- Fish
- Pine
- Soybean
- Tall
- Vegetable

Paraldehyde
Phenol
Phthalic Anhydride
Propionic Acid
Propionic Anhydride
Pyridine
Toluene
Toluidine
Turpentine
Urea Ammonia Liquor

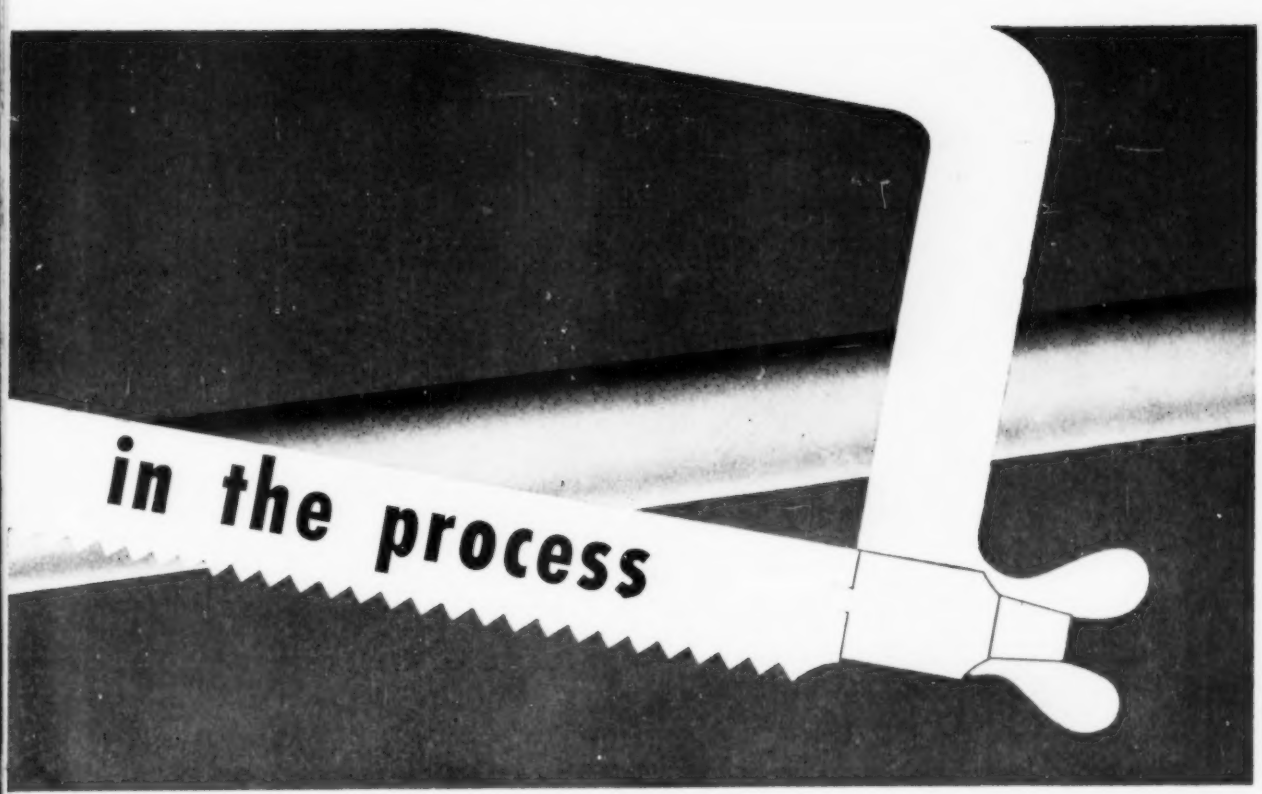
. . . and aluminum tank cars *cost a third less* than stainless steel tank cars.

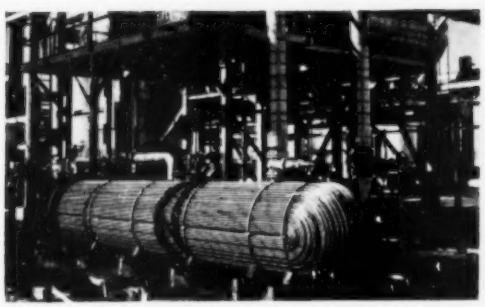


If you are shipping liquid ladings such as these, tank cars made of ALCOA Aluminum offer you very real cost-cutting advantages. Aluminum does not contaminate or discolor sensitive liquids—does not promote decomposition. Result: *no damage to ladings, better end products.* Aluminum is highly resistant to most corrosive ladings—requires far less maintenance than other metals.

Write today concerning the compatibility of your commodity in aluminum tank cars. Remember, Alcoa pioneered the aluminum tank car *years ago.* The accumulated knowledge of this development is yours for the asking.

ALUMINUM COMPANY OF AMERICA
905-M Alcoa Building, Pittsburgh 19, Pa.





Griscom-Russel Re-boiler at El Paso Natural Gas Company, Farmington, New Mexico.

Got corrosion troubles?

So did El Paso Natural Gas Company's desulfurization plant near Kirtland, New Mexico, world's largest gas treating plant. Alloy steel tubing could not withstand the terrific acid conditions there. Result: *to minimize this trouble, condenser and heat exchanger tubing throughout the plant is being replaced by aluminum.*

Got cost troubles?

Alcoa Heat Exchanger Tubes cost 1/3 less than mild steel, 1/2 the price of Admiralty, 1/5 as much as stainless. Write for the booklet: "Alcoa Aluminum Heat Exchanger Tubes."

Looking for low-cost, corrosion-resistant pipe?

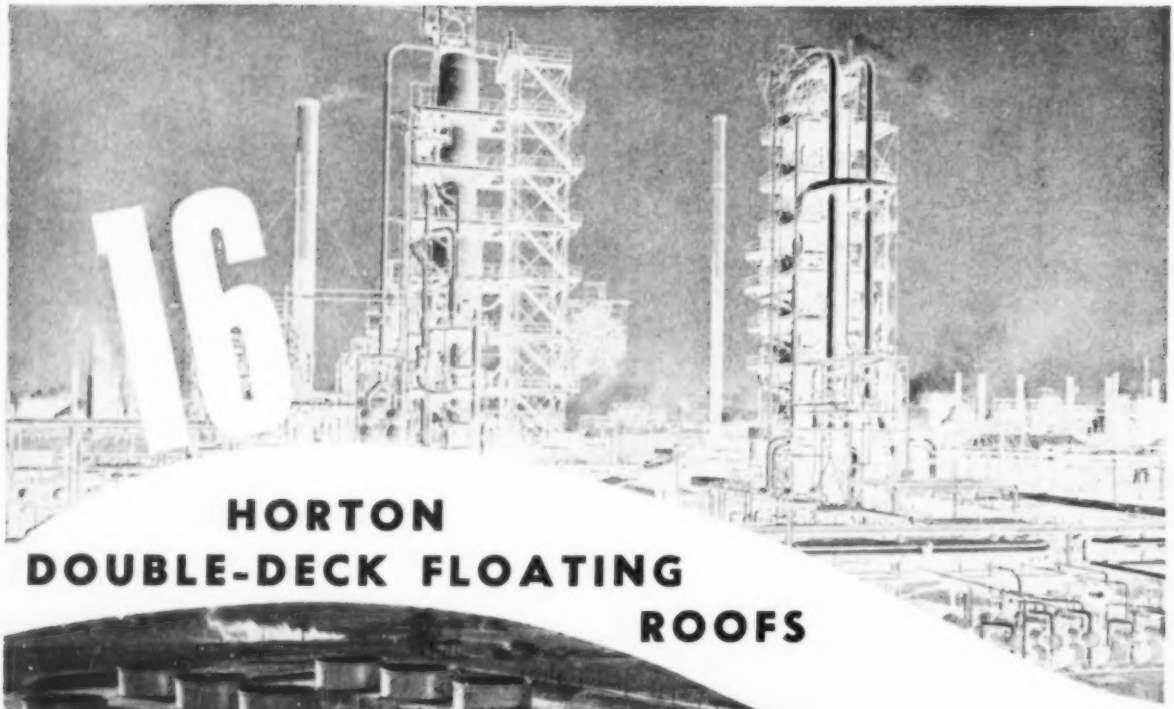
Alcoa Aluminum Pipe is the lowest cost corrosion-resistant metal pipe. Will not contaminate or discolor most chemicals. Does not cause sludge or gum in petroleum products. Ideal for railings, scaffolds, racks and other structural uses, especially in corrosive industrial atmospheres. Write for the booklet: "Alcoa Aluminum Pipe."

Don't forget corrosion-resistant sheet, plate, paint, Utilitube and shipping drums of Alcoa Aluminum. See our advertisement in Chemical Engineering Catalog.

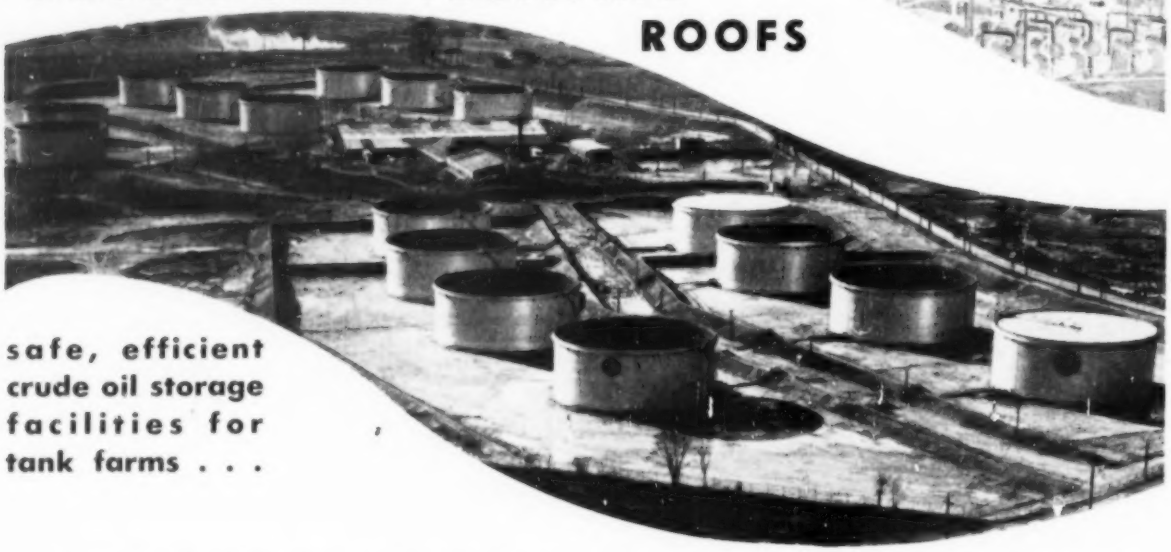
Alcoa Aluminum

ALUMINUM COMPANY OF AMERICA

"See It Now" with Edward R. Murrow . . . CBS-TV every Tuesday . . . brings the world to your armchair. Consult your newspaper for local time and channel.



HORTON DOUBLE-DECK FLOATING ROOFS



safe, efficient crude oil storage facilities for tank farms . . .

The sixteen 96,000-bbl. tanks equipped with Horton Double-Deck Floating Roofs shown above save about 40,000 bbls. of crude per year. Located at the Gulf Oil Corporation's Darby Creek tank farm near Philadelphia, Penn., the tanks have an average daily throughput in excess of 100,000 bbls.

Horton Double-Deck Floating Roofs float directly on the surface of the liquid. The bottom deck of the roof is normally in contact with the liquid. There is no space for an air-vapor mixture to form, be vented and lost. Fire hazard and corrosion are also reduced as a result of the elimination of the vapor space.

Horton Floating Roofs are built in three types, Double-Deck, Pontoon and Pan. Standard equipment on all three is the Horton Seal, a device which is highly effective in preventing evaporation loss from the space between the rim of the roof and the tank shell.

Write our nearest office for further information, estimates or quotations. Let us help you select the roof most suitable to your operations.

CHICAGO BRIDGE & IRON COMPANY

Plants in **BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNSYLVANIA**

Atlanta 3	2146 Healey Building	Detroit 26	1520 Lafayette Building	Philadelphia 3	1608—1700 Walnut Street Building
Birmingham 1	1548 North Fiftieth Street	Havana	402 Abreu Building	Pittsburgh 19	3237 Alcoa Building
Boston 10	1030—201 Devonshire Street	Houston 2	2126 C & I Life Building	San Francisco 4	1551—200 Bush Street
Chicago 4	2463 McCormick Building	Los Angeles 17	1534 General Petroleum Building	Seattle 1	1331 Henry Building
Cleveland 15	2234 Midland Building	New York 6	3302—165 Broadway Building	Tulsa 3	1626 Hunt Building

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Constructions Metalliques de Provence, Arles-sur-Rhone, France
Chicago Bridge & Iron Company, Ltd., Apartado 1348, Caracas, Venezuela
Sociedade Chibridge de Construcoes Ltda., Av. General Justo, 275, Grupo 306, Rio de Janeiro, Brazil
Horton Steel Works Limited Fort Erie, Ontario, Canada
Motherwell Bridge & Engineering Company, Motherwell, Scotland
Whessoe, Limited, Darlington, England
Comprimo N. V., 21, Amstel, Amsterdam (C) Netherlands

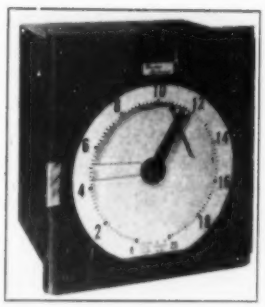
New Equipment . . .

inch.

- Direct pull strength of 12 to 15 psi.
- Acid and Alkali resistant.
- Application by brushing, dipping, or spraying.

Known as Flexrock #80, this material is available in small test lots at a very nominal price. For complete information on this unique product, just..

Circle No. 14 on Postcard



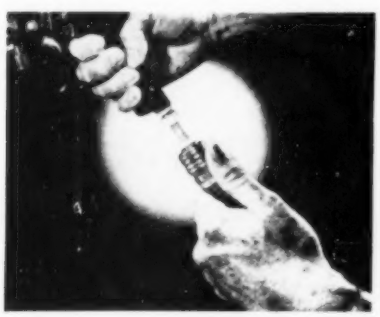
Temperature Recorder

Thermo Electric Company, Inc., is now in production on a new temperature recorder. Available in both potentiometer pyrometer and resistance thermometer bridge types, the recorder is made in a large number of different ranges from —100 to 3000 F. The recorder's usefulness is not limited strictly to temperature measurement. It can also be used for recording humidity, conductivity, pH, or any other type of measurement that can be converted to a change in resistance or d.c. millivoltage. Some features of this new instrument are:

- ½ of 1 percent of full scale accuracy
- 1/20 of 1 percent of full scale sensitivity.
- Four second full scale pen travel.
- Extreme simplicity, (only three moving parts).

For full information on this new instrument, just...

Circle No. 15 on Postcard



Swivel Air Connection

Binks Manufacturing Company is now making available to industry a new, com-

Gives you

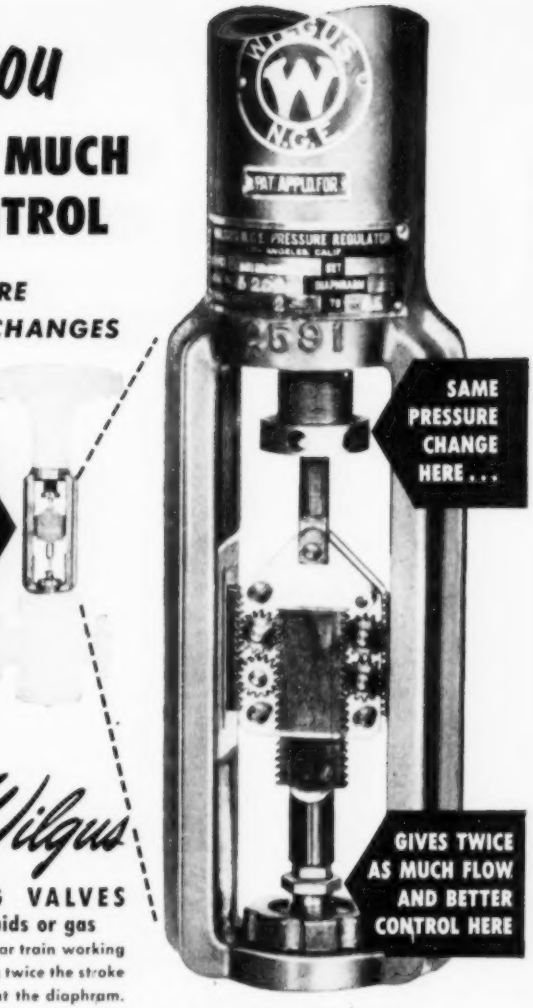
TWICE AS MUCH FLOW CONTROL

CUTS PRESSURE FLUCTUATION CHANGES IN HALF

THE THOMAS **MAGNA-STROKE*** PATENT APPLIED FOR*

A NEW DEVELOPMENT OF DESIGN AVAILABLE IN ALL N.G.E. *Wilgus* REGULATING VALVES for steam, liquids or gas

Magna-Stroke is a gear train working at a ratio of 2:1 giving twice the stroke at the inner valve as at the diaphragm.



For Process Men Everywhere Who Want Better Control

Through the use of Magna-Stroke action double efficiency is received from regulating valves. Any increase or decrease in pressure to be secured by the opening and closing of the inner valve is done so at a ratio of two to one, since the action of the diaphram is doubled at the inner valve.

Liquid or vapors which are to be maintained automatically at a desired pressure within a close limit can be maintained at half the variation due to Magna-Stroke action of doubling the pressure effect.

Pilot Instrument Actuated Valves Work Twice As Fast

For example, if 30 seconds of time is required to actuate the valve, by pressure or temperature changes in the system, the Magna-Stroke valve will in turn respond in half the time, or 15 seconds.

Bonus Qualities Of N. G. E. Wilgus Regulating Valves Equipped With Thomas Magna-Stroke Action

Valves have smaller diaphragms thus effecting better control. When Magna-Stroke action is reversed, double the power is achieved. Just one more improvement of design which makes N. G. E. Wilgus Regulating Valves the leaders of the industry.

NATURAL GAS EQUIPMENT

Write Or Wire Today For Literature

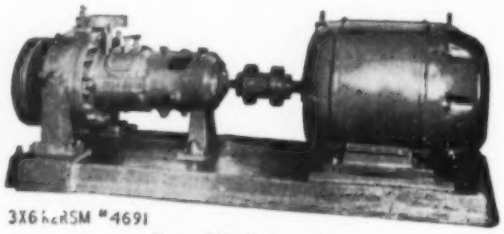
NATURAL GAS EQUIPMENT INC.
190 E. Glenarm Street, Pasadena 2, California

I am interested in Magna-Stroke action as contained in
☐ Reducing Regulators ☐ Back Pressure Regulators ☐ Motor Valves

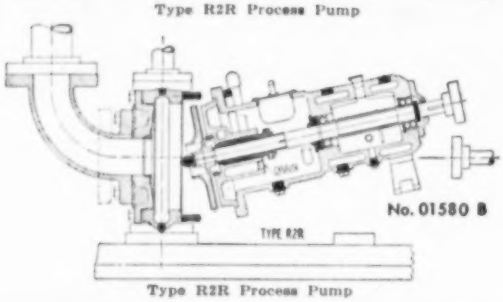
NAME _____
COMPANY _____
ADDRESS _____
CITY _____ ZONE _____ STATE _____

DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



Type R2R Process Pump



Type R2R Process Pump

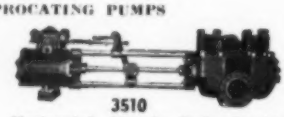
DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

OPERATING RANGE: Type R2R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute.
Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

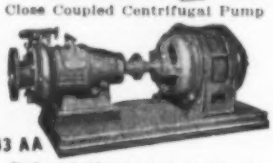
BUILDERS OF OUTSTANDING PUMPS SINCE 1869

CENTRIFUGAL and RECIPROCATING PUMPS

Close Coupled Centrifugal Pump

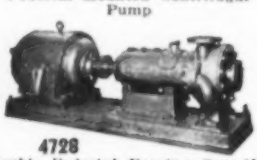


3510
Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids



4043 AA
Pedestal Mounted Centrifugal Pump

3833
Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump



4728
Double Pedestal Bearing Centrifugal Pump

3556
Durable Duplex Packed Piston Pattern Steam Pump. Side Pot Type

ESTABLISHED 1869

DEAN BROTHERS PUMPS INC.

INDIANAPOLIS IND.

323 W TENTH ST.

Branch Offices: NEW YORK, N. Y., HOUSTON, TEXAS

Representatives in Principal Cities

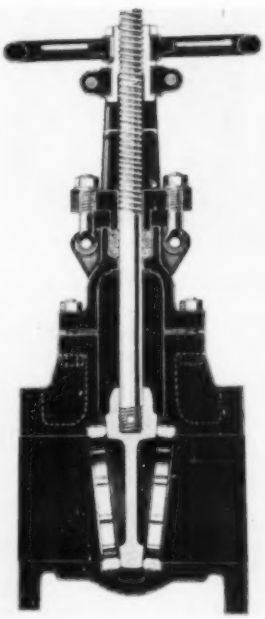
New Equipment . . .

pact, quick detachable air connection. This free-flow coupling is designed for use with paint spray guns, drills, wrenches, and other air operated power tools. Outstanding features of the new Q-D connection:

- Only 5 percent air pressure drop through the connection.
- Full 360 degree swivel action.

The Q-D connection is made for standard air hose sizes with standard pipe threads. For complete information and prices, just...

Circle No. 16 on Postcard



3% Ni Gate Valve

The Lunkenheimer Company is announcing a new 125-pound iron gate valve designed for mildly corrosive service in the refining and petrochemical industry. Both the body and bonnet of the new valve are made of 3 percent nickel iron castings, giving them an extra margin of corrosion resistance in many services. A choice of trim materials, either 18-8 Mo stainless steel or all Monel, is offered. The price of this valve is considerably lower than either all stainless or all Monel valves. Complete information on this new valve is now available.

This item supplements Lunkenheimer Company data on pages 685-688 of The Refinery Catalog, 20th Edition.

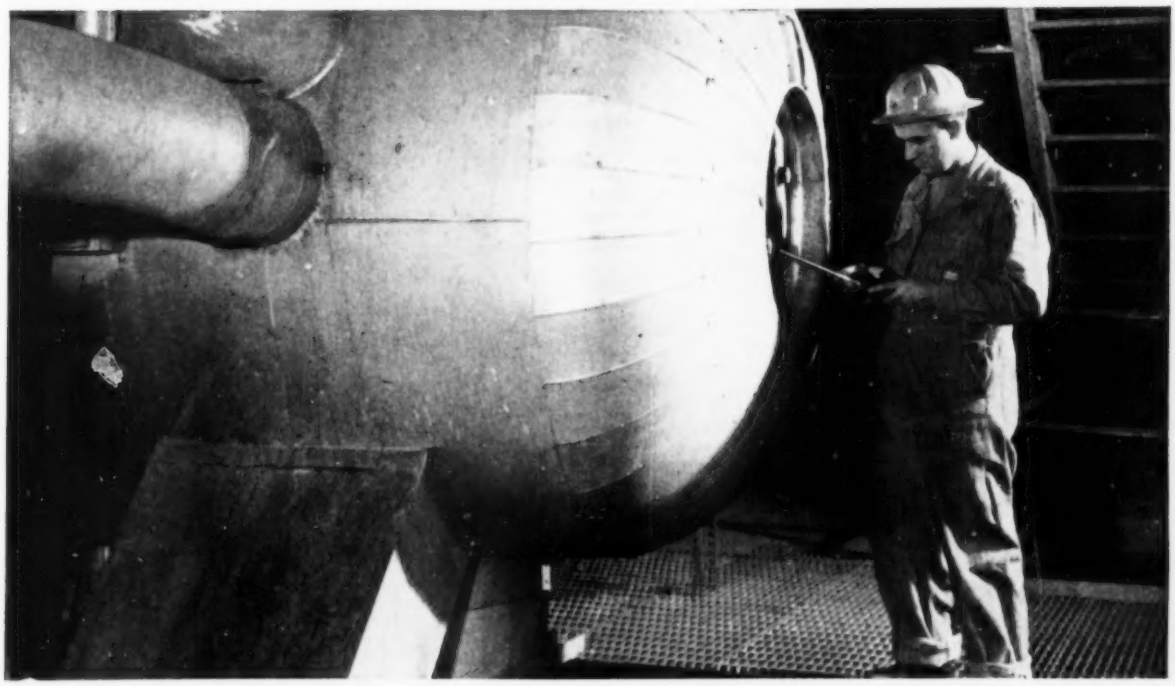
Circle No. 17 on Postcard

Unique Flow Meter

Bowser, Inc., is introducing its new Xactronic liquid flow meter, which is made in two sizes covering ranges from 32 to 950 gpm of water. The metering unit is unusually simple, consisting of a magnet enclosed stainless steel tube with Teflon liner and attached elec-

CHEMICAL CLEANING PROVED MORE EFFECTIVE IN BOILER TEST

DOWELL method showed greater efficiency by 4.5% in utility company comparison



Perhaps the most convincing way of demonstrating the advantages of one method of cleaning over another is to conduct a comparative test.

That's exactly what one of the larger utility companies did to compare chemical cleaning with mechanical cleaning. The 23-day test was conducted with companion boilers, rated at 200,000 lb. per hour operating at 500 p.s.i. One boiler was chemically cleaned by Dowell in 12 hours, the other was turbined in one week.

At the conclusion of the test, the boiler which was chemically cleaned by Dowell had a 4.5% greater efficiency factor. It also used 10% less coal per KWH gross produced than the other boiler. With results like this to cite, it's no wonder leading plants in all parts of the country rely on Dowell service for their maintenance cleaning.

Dowell engineers do the job for you, using liquid solvents which are brought to your plant in truck-mounted tanks along with all necessary pumps and control equipment. No special scaffolding is required. Dismantling and down-time are kept to a minimum; equipment can often be cleaned while in operation.

For complete information and estimates on cleaning your equipment, call the nearest Dowell office, or write directly to Tulsa, Dept. L31.

DOWELL SERVICE

Over 100 Offices to Serve You with Chemical Cleaning for:

Boilers • Condensers • Heat Exchangers • Cooling Systems
Pipe Lines • Piping Systems • Gas Washers • Process Towers
Process Equipment • Evaporators • Filter Beds • Tanks

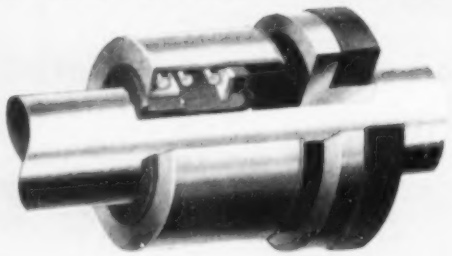
Chemical Services for Oil, Gas and Water Wells

DOWELL INCORPORATED · TULSA 1, OKLAHOMA

DOWELL

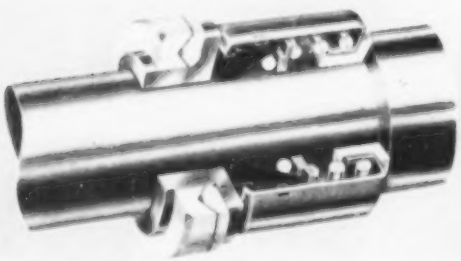
A Service Subsidiary of
THE DOW CHEMICAL COMPANY

Garlock "Package" Seals
FOR ROTATING PUMP SHAFTS



Type BB-21A—Garlock Package Seal of standard construction with brass shell, brass washer, and Buna-N bellows.

	TYPE BB-21A	TYPE AA-21A
Liquids	For water, oils, alcohol, solvents (except aromatic, chlorinated and ketone types) and other liquids (except strong acids).	For very strong acids, oils, solvents (including aromatic, chlorinated and ketone types) and all other liquids.
Equipment	Rotating shafts of centrifugal pumps, process pumps, chemical pumps, agitators and similar applications.	
Sizes	For shafts from ⅜" to 3" diameters.	
Temperatures	With Buna-N bellows up to 212°; with silicone bellows up to 450° F.	Up to 450° F.
Pressures	Up to 150 p.s.i.	Up to 150 p.s.i.



Type AA-21A—Garlock Package Seal with hat-shaped "Teflon" drive ring, brass or 316 stainless steel shell and washer, "Teflon" 'O' ring, and "Teflon" two-piece vibration ring.

✓ CHECK THESE IMPORTANT FEATURES

- ☐ Occupy very small space
- ☐ Completely assembled—ready to install
- ☐ Proven performance at low cost
- ☐ Both types are dimensionally interchangeable

In both of these Package Seals, a leakless seal is provided by a positive contact between carefully lapped metal-to-carbon mating surfaces. All metal parts in both types are available in plated-brass, Ni-Resist, stainless steel with malcomized face, Garlock "B" iron, and others.

For complete details, ask your Garlock representative or write us about your sealing problems.

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK
In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.
Branch Offices in Most Principal Cities

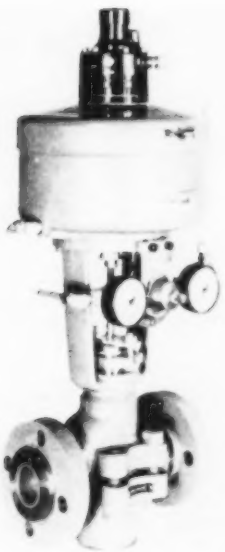
GARLOCK

PACKINGS, GASKETS, OIL SEALS,
MECHANICAL SEALS,
RUBBER EXPANSION JOINTS

New Equipment . . .

trodes. This new instrument has a rated accuracy of 1 percent, but accuracies of ¼ percent are not unusual. For complete information on this new device, just . . .

Circle No. 18 on Postcard



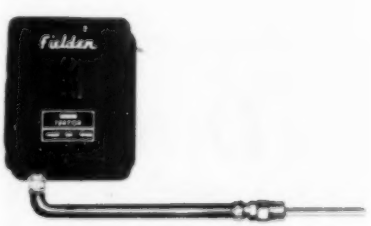
Control Valves

Conoflow Corporation is introducing a completely new line of control valves. Known as the LB series, these valves utilize an entirely new concept of valve topworks, as well as a completely new single seated, split body valve design. Some of the outstanding features of this new line are:

- Static loading in either upper or lower cylinder chamber.
- One part per thousand positioning.
- Expanded outlet sections are available.
- Teflon chevron type packing.

Full details on design, materials of construction, applications, and other features are available, just . . .

Circle No. 19 on Postcard

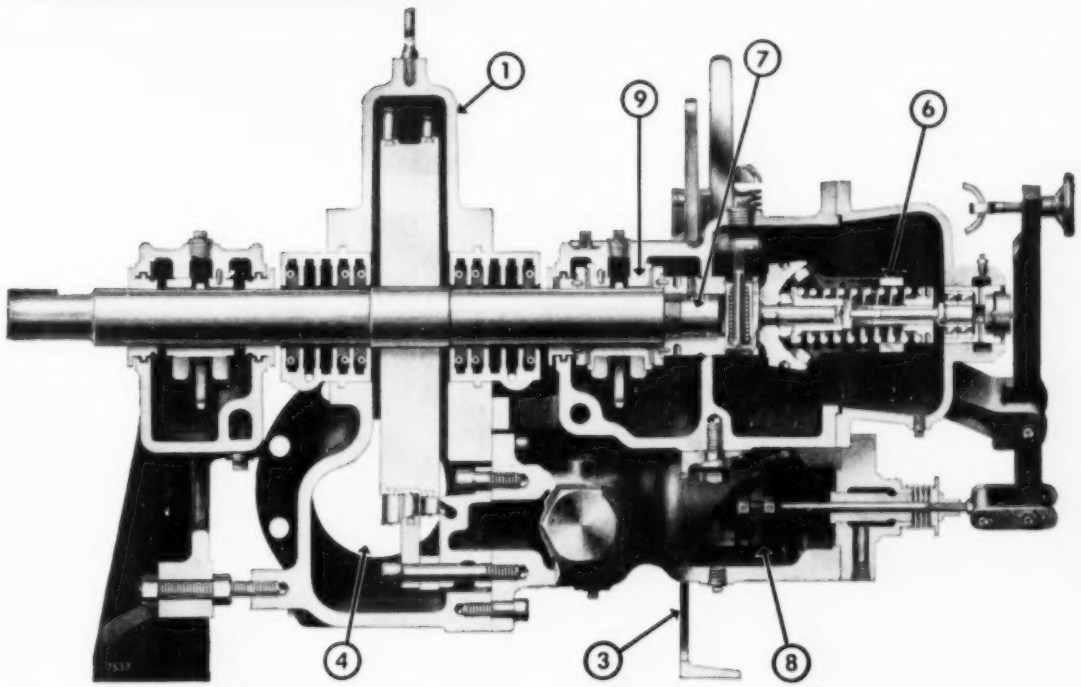


Electronic Level Control

Fielden Instrument division of Robertshaw-Fulton Controls Company is making available to the refining and petro-

NEW DE LAVAL HCB SINGLE STAGE TURBINE

can be ordered from stock



1 Case and Cover Split Horizontally on centerline for ease of maintenance.

2 True Centerline Casing Support assures distortion-free radial expansion. *Not shown.*

3 Flexible Support at governor end provides for axial expansion.

4 Exhaust Opening either right or left side for installation flexibility.

5 Steam Strainer, protecting trip and governor valves, is *removable* for cleaning without breaking steam connections. *Not shown.*

6 Constant Speed Governor features governor weights pivoted around frictionless surfaces.

7 Complete Governor Assembly is now *replaceable as a unit.*

8 Balanced Single Seated Main Governor Valve has proportional flow characteristics for sensitive, positive control.

9 Shaft Locating Bearing of adjustable double collar type.

Horsepower: 100 MAX
Steam Pressure: 300 PSIG MAX
Steam Temperature: 550F MAX
Exhaust Pressure: 25 PSIG MAX
Speed: 4,000 RPM MAX
Steam Inlet: 2"–250# ASA FLG.
Exhaust: 6"–150# ASA FLG.
Weight: 1,200 LB

Here's the new De Laval HCB Single Stage Turbine which is now "on the shelf" . . . ready for immediate shipment. This mechanical drive turbine is simple, rugged, designed for long economical life and low maintenance. For example, note the true centerline casing support, the replaceable governor, the removable steam strainer. Investigate all the advantages of this versatile driver. It is ready to handle—*at low cost*—a variety of applications in your plant.

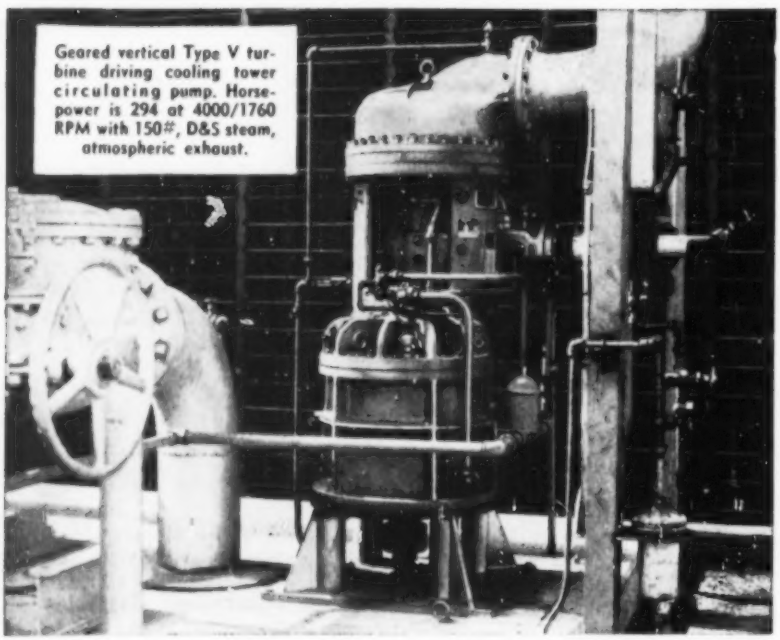
Send for new Bulletin 4206
which gives vital facts and figures

DE LAVAL *Mechanical Drive Turbines*

DE LAVAL STEAM TURBINE COMPANY
811 Nottingham Way, Trenton 2, New Jersey

DL-3108

Murray Turbines



Geared vertical Type V turbine driving cooling tower circulating pump. Horsepower is 294 at 4000/1760 RPM with 150#, D&S steam, atmospheric exhaust.

● Murray Vertical V turbines, both geared and direct-connected, are being used more and more for driving vertical pumps of all types. The Murray Vertical V turbine is designed from top to bottom as a vertical turbine, not just a horizontal turbine, "upended." The Murray Vertical is especially constructed and arranged for vertical mounting.

Murray vertical turbines can be furnished for steam pressures up to 600#, 750° F. TT. and back pressures as high as 100# and can carry most normal thrust loads imposed by vertical pumps.

MURRAY IRON WORKS COMPANY
BURLINGTON, IOWA

Builders of Steam Power Equipment for Three Quarters of a Century

New Equipment . . .

chemical industry a new level control. This new Tektor level control is an improved capacitance unit with no moving parts. The unit operates, through a simplified electronic circuit, by a change in the electrical capacitance of the electrode caused by the approach of any material that flows. Control as close as 1/16-inch of liquid, divided solids, interfaces, conducting or non-conducting wet or dry materials can be provided by the instrument. New features include:

- Easily accessible trimmer adjustment.
- Single tube circuit.
- Complete stability and high sensitivity.

For complete information on this new instrument, just...

Circle No. 20 on Postcard

Unique Mass Spectrometer

General Electric Company's Special Products division announces a new mass spectrometer designed specifically to meet process instrumentation needs in the gas, petroleum and petrochemical fields. Developed by the company's General Engineering Laboratory, the new spectrometer utilizes the most recent development in the field, the principle of ion resonance. Some of the features of this new instrument are:

- Sample inlet system which allows continuous sample introduction.
- Operating range from 1 to 100 mass units.
- Programming which allows automatic and repetitive continuous spectrum scanning.
- Minor modification allows automatic monitoring of one or more peaks in sequence.

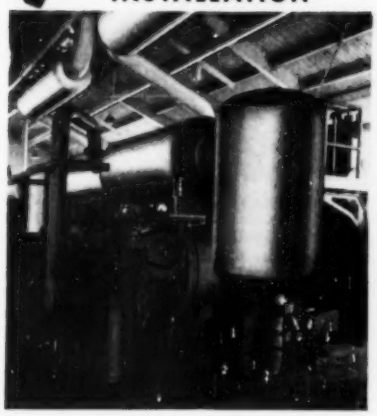
Complete data on this product is

BURGESS-MANNING Pulsation Snubbers

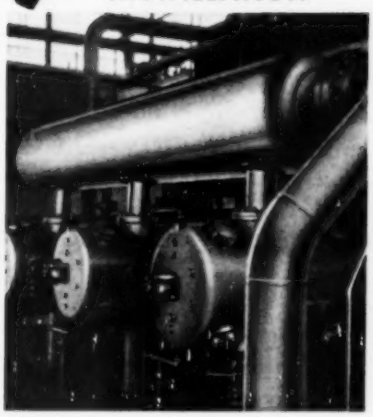
included in NEW PLANT DESIGNS by many leading

PROCESSING ENGINEERING and CONTRACTING COMPANIES

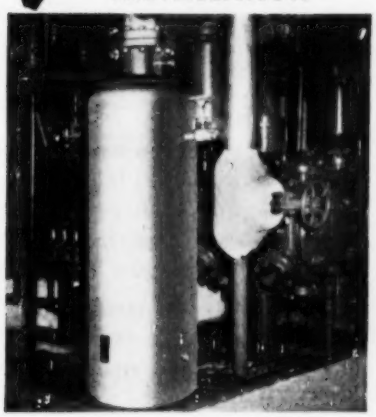
TYPICAL OIL-REFINERY INSTALLATION



TYPICAL GAS PIPE-LINE INSTALLATION



TYPICAL CHEMICAL-PLANT INSTALLATION



Burgess-Manning experience and "know-how" in the control of surge in gas and air piping can be of valuable service to all processing, engineering, and contracting companies faced with designing piping systems without pulsation problems.

Pulsation snubbing has proven its effectiveness in best efficiency, process action, gas transmission, and gas metering.

To help you overcome pulsation and vibration in gas and air lines excited by compressors, reciprocating pumps, or blowers, Burgess-Manning Company's specialized engineering group is available to study and analyze flow conditions. Recommendations and designs for each project will be developed as required. Supplemental field surveys can be made where existing operations are involved.

If you are confronted with the problem of reducing pulsation in gas pipe lines, consult with Burgess-Manning. Recommendations for your piping projects will be developed at your request.

BURGESS-MANNING COMPANY

SOUND ENGINEERING

1203 DRAGON STREET
DALLAS, TEXAS

CHICAGO, ILLINOIS • LIBERTYVILLE, ILLINOIS • REPRESENTATIVES: HOUSTON • TULSA • LOS ANGELES • ST. LOUIS • NEW YORK

STOP CORROSION
with BIRD-ARCHER AMINE TREATMENT

Unretouched photograph shows the ravages of corrosion on condensate return lines.

Corrosion of piping in steam and condensate return lines is an expensive two-way headache. (1) It leads to large outlays for pipe replacement and maintenance. (2) It often results in plugged return lines and traps due to the solid products of corrosion. Bird-Archer Amine Treatment effectively eliminates these troubles at low cost.

Here's how. Amines are fed into the boiler or into the steam and condensate systems. The amines raise the pH value of the condensate and also tend to inhibit equipment-destroying corrosion through surface protection of the metal itself. In scores of plants, this Bird-Archer system has more than paid for itself by substantially cutting replacement and maintenance costs.

BA 902

Bulletin CP 100 gives all the facts on Bird-Archer Amine Treatment. Write for your copy.

LABORATORIES ENGINEERS · CHEMISTS

BIRD-ARCHER
WATER TREATMENT

THE BIRD-ARCHER COMPANY, 4337 NORTH AMERICAN ST., PHILADELPHIA 40, PA.
NEW YORK • CHICAGO

IN CANADA: The Bird-Archer Co., Limited, Cobourg, Ontario
IN MEXICO: Calderas y Accesorios, S. A., Amsterdam 291, Mexico, D. F.

New Equipment . . .

available now.

This item supplements General Electric Company data on pages 492-493 of The Refinery Catalog, 20th Edition.

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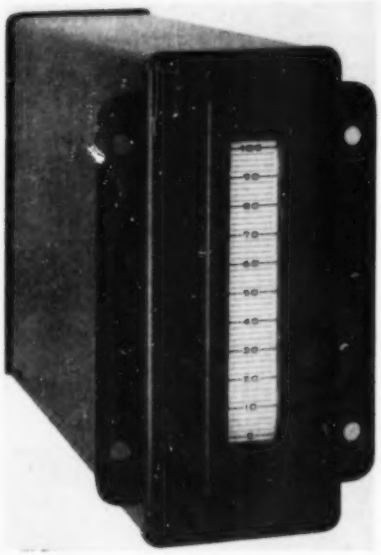


Ribbon Type Indicator

A new ribbon-type indicator receiver has been announced by The Foxboro Company. The indicator receives pneumatic measurements from a transmitter at the process. This force is applied to a sensitive receiver bellows which, through a lever and type arrangement, rotates two lightweight drums. A colored nylon tape, wound on the drums, is drawn behind a scale glass.

Some of the features included in the announcement are:

- Internal illumination unnecessary.
- Reduced maintenance.
- Optional alarm contacts.
- Adjustable for direct or reverse response.

Circle No. 22 on Postcard

Rugged Sight Glasses

Sight glasses that remain transparent indefinitely and withstand severely corrosive conditions, extreme temperatures, shock and vibration are now being molded by Nichols Engineering, Inc. Made of "Kel-F" fluorocarbon material of The M. W. Kellogg Company, these new "glasses" are virtually chemically inert. Some of the outstanding features of this new product are:

- No shattering or cracking.
- Kel-F's non-stick characteristic prevents accumulation of deposits—less maintenance.
- Extreme chemical inertness.
- High impact strength prevents damage from tools or rough handling.

For the information you need concerning this new product, just . . .

Circle No. 23 on Postcard

When fluid flow connections must combine flexibility with corrosion resistance

Specify

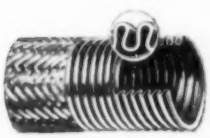
CMH REX-FLEX

The Stainless Steel

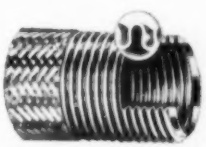
FLEXIBLE METAL HOSE

You can stop dangerous and wasteful leakage of toxic or corrosive substances by using REX-FLEX as the flexible link in connections subject to vibration, flexation, misalignment or expansion and contraction. CMH REX-FLEX offers complete dependability even where the frequency of the motion is high. The inherent characteristics of stainless steel coupled with Flexonics' manufacturing "know-how" assure a corrosion resistant unit that will stand up in the toughest service.

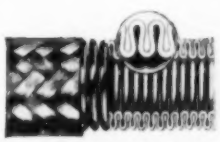
When you specify REX-FLEX stainless steel hose you put to work for you a knowledge of the use of flexible stainless steel components that is unequalled. Whatever your stainless steel hose problem, it will pay you to bring it to Flexonics Corporation. For specific recommendations just send an outline of your requirements.



REX-FLEX TYPE RF-51—Sizes ⅜" through 2", I.D., for temperatures to 1,600° F working pressures to 4700 psi; with metal braid covering. Available in standard or heavy wall types. Also supplied unbraided as Type RF-50.



REX-FLEX TYPE RF-41—Sizes ⅛" through 6", I.D., for temperatures to 1,600° F working pressures to 525 psi (1 ply) and 1050 psi (2 ply); with metal braid covering. Open and close pitch types and standard and heavy wall constructions supplied. Also available unbraided as Type RF-40.



REX-WELD TYPE RW-81 (Stainless)—Sizes ¼" through 2", I.D.; heavy wall hose for temperatures to 1,600° F, with metal braid covering. Also available unbraided as Type RW-80 (Stainless).

See our catalog in Sweet's Plant Engineering File or Chemical Engineering Catalog.

CHICAGO METAL HOSE Division

Flexonics *Corporation* 1336 South Third Avenue, Maywood, Illinois

In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

Flexon identifies CMH products that have served industry for over 50 years.

CMH

Flexible metal hose

Expansion joints

Aircraft components

Metallic bellows

New Equipment Literature

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Circle A1 on postcard.

TUBE CLEANERS AND EXPANDERS—Information. Airetool Manufacturing Co. See page 178.
Circle A2 on postcard.

STEEL FLOOR PLATE—Booklet A1-19. Alan Wood Steel Co. See page 177.
Circle A3 on postcard.

WATER CONDITIONING SERVICE—Bulletin 53. Allis-Chalmers Manufacturing Co. See page 11.
Circle A4 on postcard.

PROCESS PUMPS—Literature. Allis-Chalmers Manufacturing Co. See pages 12-13.
Circle A5 on postcard.

ALUMINA CATALYSTS AND CATALYST SUPPORTS—Information. Aluminum Company of America. See page 8.
Circle A6 on postcard.

ALUMINUM PIPE—Booklet. Aluminum Company of America. See pages 164-165.
Circle A7 on postcard.

PIPE INSULATION—Literature. American Gilsonite Co. See page 15.
Circle A10 on postcard.

CATALYTIC REFORMING—Bulletin. The Atlantic Refining Co. See pages 204-205.
Circle B3 on postcard.

ELECTRONIC RESISTANCE THERMOMETER—Bulletin 230-C. Bailey Meter Co. See page 179.
Circle B10 on postcard.

PACKAGED COMPRESSOR PLANTS—Information. The J. B. Beaird Co. See page 200.
Circle C1 on postcard.

CAST STEEL FITTINGS—Catalog 153. The J. B. Beaird Co. See page 201.
Circle C2 on postcard.

AMINE TREATMENT—Bulletin CP 100. The Bird-Archer Co. See page 174.
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STEEL GRATING—Information. Blaw-Knox Co. See page 190.
Circle C6 on postcard.

CONDENSER AND HEAT EXCHANGER TUBES—Handbook. Bridgeport Brass Co. See page 159.
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PNEUMATIC TRANSMISSION INSTRUMENT SYSTEM—Information. The Bristol Co. See page 44.
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MOTOR UNITS—Catalog No. 50. The Chapman Valve Manufacturing Co. See page 187.
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SWIVEL JOINTS—Catalog 53-C. Chiksan Co. See page 39.
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ALUMINUM JACKETING—Information. Childers Manufacturing Co. See page 32.
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COMPRESSORS—Bulletin 130. Clark Bros. Co. See pages 60-61.
Circle D8 on postcard.

STEAM TRAPS—Brochure. The Clark Manufacturing Co. See page 45.
Circle D9 on postcard.

STEAM TURBINES—Bulletin 4206. De Laval Steam Turbine Co. See page 171.
Circle E5 on postcard.

MATERIAL HANDLING SYSTEM—Information. Dempster Brothers, Inc. See page 50.
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ALLOY CASTINGS—Bulletin No. 3150-G. The Duraloy Co. See page 142.
Circle F1 on postcard.

METALLIC PACKINGS AND MECHANICAL SEALS—File No. FPR. Durametallic Corp. See page 228.
Circle F2 on postcard.

GUM INHIBITORS—Booklets. Eastman Chemical Products, Inc. See page 46.
Circle F3 on postcard.

CENTRIFUGAL BLOWERS—Information. Elliott Co. See page 137.
Circle F4 on postcard.

TUBE CLEANERS—Bulletin Y-34. Elliott Co. See page 191.
Circle F5 on postcard.

TOTALIZER—Information. Fischer & Porter Co. See page opp. 64.
Circle F6 on postcard.

V-RING PACKING—Bulletin E-200. Fisher Governor Co. See IV Cover.
Circle F7 on postcard.

AUTOMATIC CONTROLLER—Bulletin 463. The Foxboro Company. See pages 52-53.
Circle G2 on postcard.

PACKAGE SEALS FOR ROTATING PUMP SHAFTS—Information. The Garlock Packing Co. See page 170.
Circle G3 on postcard.

PETROLEUM BOOKS CATALOG—The Gulf Publishing Co. See page 196.
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CONCRETE CONSTRUCTION—Bulletins. Gunite Concrete & Construction Co. See page 228.
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COOLING TOWER AND HEAT EXCHANGER FANS—Bulletin 1503. Hartzell Propeller Fan Co. See page 232.
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ALLOY METAL—Booklet. The International Nickel Co. See page 9.
Circle H4 on postcard.

WIRE MESH PRODUCTS—Information. The C. O. Jelliff Mfg. Co. See page 197.
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THREAD LUBRICANT AND SEAL—Information. Jet-Lube, Inc. See page 196.
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INSULATION—Information. Keasbey & Mattison Co. See page 185.
Circle H9 on postcard.

LIQUID PUMPS—Bulletin L-51. Kinney Manufacturing Co. See page 210.
Circle J4 on postcard.

OXIDATION INHIBITOR—Information. Koppers Co. See page 162.
Circle J6 on postcard.

WATER SUPPLY SYSTEMS—Information. Layne & Bowler, Inc. See page 55.
Circle J8 on postcard.

FILTERS—Bulletin FO-52. Warner Lewis Co. See page 209.
Circle J9 on postcard.

TANK TRAILERS—Information. Lubbock Machine & Supply Co. See page 192.
Circle J10 on postcard.

STEEL GATE WELD VALVES—Information. Manning, Maxwell & Moore, Inc. See page 231.
Circle K2 on postcard.

CHEMICAL FEEDERS—Information. Manzel. See page 180.
Circle K3 on postcard.

VALVES—Bulletin 800. Minneapolis-Honeywell Regulator Co. See pages 216-217.
Circle K7 on postcard.

MIXERS—Catalogs. Mixing Equipment Co. See page 74.
Circle K8 on postcard.

FUEL OIL-GAS BURNERS—Information. National Airoil Burner Co. See page 224.
Circle K10 on postcard.

PIPES AND TUBES—Information. National Tube Division. See page 38.
Circle L2 on postcard.

REGULATING VALVES—Literature. Natural Gas Equipment Inc. See page 167.
Circle L3 on postcard.

REFINERY EQUIPMENT CONSTRUCTION—Literature. Newport News Shipbuilding & Dry Dock Co. See page 23.
Circle L4 on postcard.

STEAM TRAPS—Bulletin 853. W. H. Nicholson & Co. See page 209.
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REFRACTORY MATERIALS—Booklet. Norton Company. See pages 36-37.
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SCALE AND RUST REMOVAL—Booklet. Oakite Products, Inc. See page 195.
Circle L8 on postcard.

PROCESS PUMPS—Bulletins 101 and 108. Pacific Pumps, Inc. See page 212.
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STEEL TUBING—Catalog. Pacific Tube Co. See page 5.
Circle M1 on postcard.

AUTOMATIC WELDING WIRE—Bulletin DH-402. Page Steel & Wire Division. See page 156.
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TEMPERATURE INDICATING INSTRUMENTS—Catalog 200-G. Palmer Thermometers, Inc. See page 214.
Circle M3 on postcard.

GREASE KETTLES—Information. The Patterson Foundry & Machine Co. See page 69.
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PUMPS—Bulletin No. B-1605. Peerless Pump Division. See page 17.
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LIQUID LEVEL GAGES—Catalog 35. Penberthy Injector Co. See page 65.
Circle M6 on postcard.

PROCESS ENGINEERING—Information. Perco Division, Phillips Petroleum Co. See page 66.
Circle M7 on postcard.

AUTOMATIC VALVE OPERATOR—Catalog. Philadelphia Gear Works, Inc. See page 7.
Circle M9 on postcard.

HEATING AND COOLING PROCESS COILS—Bulletin P78. Platecoil Division, Tranter Manufacturing, Inc. See page 148.
Circle M10 on postcard.

BUBBLE CAPS AND RISERS—Catalog 52. The Pressed Steel Co. See page opp. 65.
Circle N2 on postcard.

FORGED STEEL VALVES—Literature. Reading, Pratt & Cady Division. See page 145.
Circle N4 on postcard.

BOILER, CONDENSER AND HEAT EXCHANGER TUBES—Booklet. Republic Steel Corp. See page 59.
Circle N6 on postcard.

CONDENSER PLATES AND TUBES—Booklet. Revere Copper and Brass, Inc. See page 135.
Circle N7 on postcard.

DIAL THERMOMETERS—Information. Rochester Manufacturing Co. See page 201.
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LUBRICANT-SEALED VALVES—Information. Rockwell Manufacturing Co. See pages 30-31.
Circle P1 on postcard.

STEEL UNIONS—Information. Rockwood Sprinkler Co. See page 47.
Circle P2 on postcard.

HEAT EXCHANGER TUBES—Booklet. Scovill Manufacturing Co. See page 54.
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PUMP VALVES—Bulletin PR-1. Sims Pump Valve Co. See page 197.
Circle P9 on postcard.

MERCURY MANOMETER—Bulletin 98182. Taylor Instrument Companies. See page 49.
Circle Q4 on postcard.

STEAM TURBINES—Bulletin S-116. The Terry Steam Turbine Co. See page 34.
Circle Q5 on postcard.

THERMOCOUPLE EXTENSION WIRES—Bulletin 31-X. Thermo Electric Co. See page 222.
Circle Q7 on postcard.

NUCLEAR INSTRUMENTS AND SUPPLIES—Catalog C-1. Tracerlab, Inc. See page 202.
Circle Q9 on postcard.

VALVE AND PUMP PACKING—Catalogs Nos. 711 and 810-V. United States Gasket Co. See page 186.
Circle Q10 on postcard.

INDUSTRIAL CONCRETES—Information. Universal Atlas Cement Co. See page opp. 49.
Circle R3 on postcard.

PROCESS VALVES—Bulletin 698. W-K-M Company. See page 70.
Circle R7 on postcard.

SOCKET-WELDING FITTINGS—Literature. Watson-Stillman Fittings Division, H. K. Porter Co. See page 19.
Circle S1 on postcard.

THERMOMETERS—Literature. Weston Electrical Instrument Corp. See page 158.
Circle S3 on postcard.

STEAM TRAPS—Book. Yarnall-Waring Co. See II Cover.
Circle S6 on postcard.

EXPANSION JOINTS—Bulletin 351. Zallea Brothers. See page 25.
Circle S8 on postcard.

New Books . . .

Industrial Research

Scientific Research and Development in American Industry—A Study of Manpower and Costs, United States Department of Labor, Bureau of Labor Statistics, Washington, D. C. $.50. (Copies may be purchased from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.)

In this comprehensive and detailed report on the nation's industrial research resources, nearly 2000 companies, with about 6.5 million employes and sales totaling nearly $100 billion in 1951, were studied. The companies' scientific and engineering research programs cost almost $2 billion in 1951—about 85 percent of the total national cost of industrial research and development. In addition to 96,000 engineers and scientists, their research staffs included 143,000 supporting workers.

The extent to which the supporting workers are used to assist research engineers and scientists has become a matter of great interest and importance in research management. There were fewer supporting personnel than professional research workers in over half the reporting companies. However, some firms made much greater use of supporting workers—a few had as many as 8 or 9 per research engineer or scientist.

In releasing the bulletin, the Bureau pointed out that it is the full report on a mail questionnaire survey conducted by the Department of Defense.

The survey shows that industrial research is concentrated to a large extent in large companies. About 40 percent of the research engineers and scientists worked for the 44 largest companies in the study, each of which had more than 25,000 employes. In contrast, only 4 percent was employed by the 642 reporting companies with fewer than 100 employes.

The average cost per research engineer or scientist was $21,900 in 1951, in all of the surveyed companies taken together. Average cost per research worker, professional or non-professional, was $8800. These cost figures are overall averages for all companies in the survey. Since most industrial research is performed by the few large companies, their costs greatly influence the average.

Other topics discussed in the bulletin include the rate of turnover of professional research staffs and the past potential effects of military calls of such employes; research engineers and scientists as a percent of total company employment; research costs as a percent of sales; both employment and costs on government prime contracts and subcontracts for defense research; and the extent of increase in government-financed and company-sponsored research between January, 1951, and January, 1952.

Atomization Survey

The Atomization of Liquid Fuels, E. Giffen and A. Muraszew, John Wiley & Sons, 440 Fourth Avenue, New York 16. $6.

Characteristics, properties and the

...Then **ALGRIP** Ended Deadly Slips and Falls that Skyrocketed Insurance Costs!

"Fall Guys" was the name men gave themselves in the drum-filling room of a southwestern refinery. For the oil-splashed floor was treacherous underfoot—and crippling falls were frequent.

Banished: Slipping accidents that crippled workmen and production.

Slashed: The needless cost of extra compensation premiums.

Slipping accidents ended at once when we installed A.W. ALGRIP Abrasive Rolled Steel Floor Plate. And compensation rates dwindled to a new low. For A.W. ALGRIP is a true non-skid floor plate—safe underfoot even when wet or oily—even on steep inclines! Tough, abrasive, "grinding-wheel" grain—rolled uniformly into its upper portion—puts hundreds of tiny safety brakes in every footstep. It's nearly impossible to slip on ALGRIP.

Rough, rugged, long-lasting ALGRIP can stop your slipping accidents, too. And you'll find it pays for itself in savings from safety. For real foot safety and lower insurance rates, get the full ALGRIP story today. Write for our new Booklet AL-19 on accident prevention. It's cost-free.

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Other Products: A. W. SUPER-DIAMOND Floor Plate • Plates • Sheet • Strip (Alloy and Special Grades)

ALWAYS a good job well done...

with AIRETOOL tube cleaners and expanders

For really effective tube cleaning in any refinery unit, tools must have power—power to rapidly and efficiently remove hard-rock coke deposits. AIRETOOL high speed motors have that power. Ball bearing thrusts at both front and rear assure constant torque at all speeds—loaded down to as low as 50 RPM, they will not bog down or stall! All AIRETOOL motors are tough but still easily maintained; all parts are ground to a slip-fit requiring no special tools. See how easily you can save time and money on tube maintenance; write to The AIRETOOL Manufacturing Co., 316 S. Center St. Springfield, Ohio.

AIRETOOL series "6000" ball bearing motor, shown with single expansion type cutter head for thoroughly cleaning coke from straight tubes.

There's an AIRETOOL TUBE CLEANER and TUBE EXPANDER for Every Type of Tubular Construction

Solve tube expansion problems

For accurate, consistent rolling of condensers or heat exchangers, tube ends, AIRETOOL Tube Expansion System automatically rolls joints to uniform and maximum tightness, eliminating all possibilities of over-expansion of tubes and distortion of tube sheet.

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New Books . . .

most useful results of the atomization of liquid fuels are surveyed in this 246-page book. The authors discuss the mechanism of disintegration of liquid jets, fuel spray characteristics, simple theory of the swirl atomizer, and the use of dimensional analysis for correlation of atomization data.

Other topics covered are formation and development of intermittent and continuous sprays, experimental methods for assessment of fuel spray characteristics and the effect of: physical properties of the liquid on spray characteristics, properties of the gaseous medium on spray characteristics, and injection pressure on spray characteristics.

The authors are presently of London. Dr. Griffen is professor of civil and mechanical engineering at Queen Mary College there; Dr. Muraszew has conducted individual research in the field as well as collaborated with Dr. Griffen in experiments and earlier papers.

Petroleum Hydrocarbons

Hydrocarbons From Petroleum, The Fractionation, Analysis, Isolation, Purification and Properties of Petroleum Hydrocarbons, Frederick D. Rossini, Beveridge J. Mair and Anton J. Streiff, Reinhold Publishing Corporation, 330 W. 42nd Street, New York 36. $18.50.

Results of over a quarter of a century of work by the American Petroleum Institute Research Project 6 on the fractionation, analysis, isolation, purification, and properties of petroleum hydrocarbons have been described in over 140 technical and scientific publications. This important monograph summarizes this knowledge and data.

Outstanding among the many valuable features of the book is the large number of charts, graphs and tables, many of which are so detailed that it was necessary to include them as fold-out inserts.

The carefully tabulated information contained in this book will make this monograph a valuable addition to the reference shelves of technical libraries and laboratories, and should be of constant use to research chemists in the petroleum and related fields.

Methane-Ethane System

IGT Research Bulletin 22. Physical-Chemical Properties of Methane-Ethane Mixtures, O. T. Bloomer, D. C. Gami and J. D. Parent, Institute of Gas Technology, Technology Center, Chicago 16. $3.50

This bulletin, the 22nd in a series of publications on research conducted in the libraries and laboratories of the Institute of Gas Technology, presents the results of one phase of the determination of the physical and thermo-dynamic properties of natural gas components and their mixtures. These data are required for the engineering design of plants to separate pure components of natural gas.

Liquid-vapor equilibria, gas phase pressure-volume-temperature relationships, and saturated liquid and vapor density data for the methane-ethane systems have been determined by a detailed experimental investigation with

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by BAILEY...

Your best buy for Precision Temperature Measurements In the -300F to 1200F Range

Check These Exclusive Bailey Advantages of Resistance Thermometer Operation

✓ Resistance thermometer operation over a complete range from —300F to 1200F has been made possible by Bailey's development of a low-cost platinum resistance element.

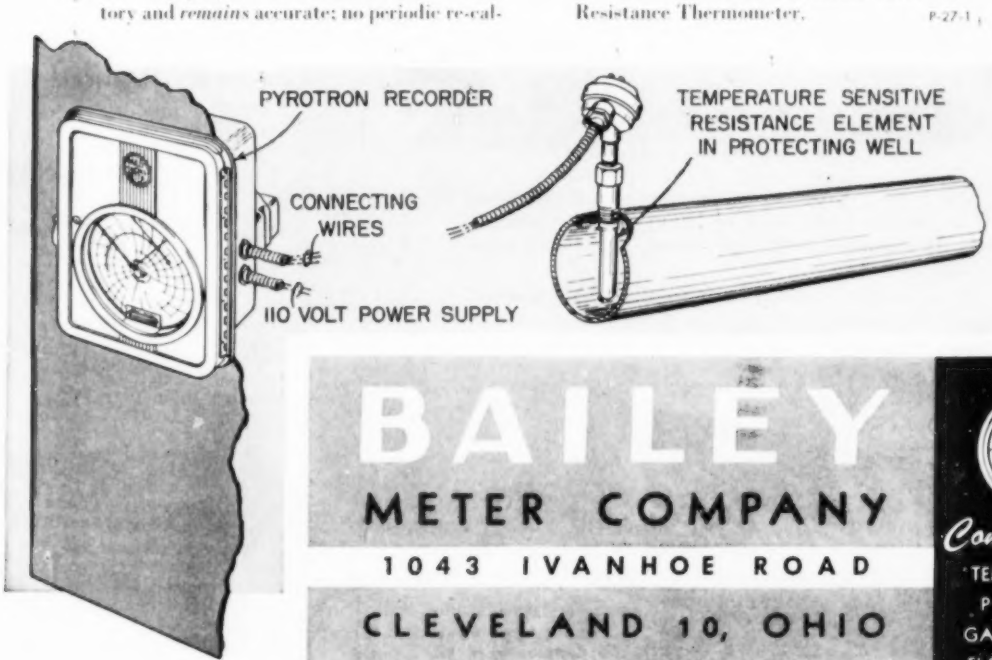
✓ Resistance thermometer operation requires no standard cell, dry battery and cold junction compensator. Uses 115 volt a-c source. Strong signal and high precision of resistance element as compared to thermocouple makes possible the use of narrow range spans.

✓ The Bailey Pyrotron is calibrated at the factory and *remains* accurate; no periodic re-calibrations required. Since all elements are matched it is not necessary to calibrate each recorder to its element.

✓ Recorder is sensitive to 1/10 of 1% of range span.

✓ Ordinary copper lead wires permit remote location of recorder with respect to the temperature sensing element.

✓ For complete information, write for bulletin 230-C on the Bailey Pyrotron Electronic Resistance Thermometer. P-27-1



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CLEVELAND 10, OHIO
Complete Controls for Process Plants

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Controls for
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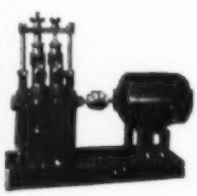
Whatever YOUR Need in Chemical Feeders

MULTI-FEED CHEMICAL FEEDERS

Manzel flexibility permits *accurate* feeding of *many* different chemicals simultaneously. Chemicals can be pumped *into* other liquids or test samples drawn from production at regular intervals. The illustration shows a Manzel with 7 feeds, each of which can be individually set to draw an exact amount of chemical from its own tank

LARGE OR SMALL CAPACITIES

Manzels Chemical Feeders pump from a fraction of a drop to 60 gph per feed . . . with *unsurpassed accuracy and dependability*. You eliminate troubles due to guesswork, inaccuracy, or forgetfulness. Any number of feeds, any type of drive. Easily synchronized with any process



● When you have a problem of feeding one liquid into another . . . no matter how light, or heavy, or corrosive . . . you can rely on Manzel's long experience in *precision* proportional pumping.

Manzel Chemical Feeders can be individually engineered for most applications . . . and they are priced much lower than you might expect. Write for details today.

Ask Manzel

Division of Frontier Industries, Inc.
285 Babcock Street
Buffalo 10, N. Y.

SPECIALIZING IN HIGH PRESSURE METERING PUMPS SINCE 1898

New Books . . .

specific mixtures of methane and ethane. Presented in a form useful for engineering calculations, the bulletin covers a pressure range from 50 to 4000 psia and temperatures from —210 F. to 90 F.

API Refining Division Readies Two Publications

The API Division of Refining will soon publish two publications of interest to refiners. One is a set of specifications for centrifugal pumps for refinery service, the other Part V of a recommended practices handbook for refinery inspectors. Other parts of the latter booklet are still under preparation.

Both booklets have passed various committee approvals and await only final approval of the general committee of the Division of Refining before going into print.

Mines Bureau Releases Diesel Fuel Survey

Results of its fourth annual diesel fuel survey made in cooperation with the API have been released by the Bureau of Mines. The report covers 278 samples made in 110 refineries. Free copies may be obtained from Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13.

H. J. Crawford Dies

Harry Jennings Crawford, director and board chairman of Quaker State Oil Refining Corporation, died recently at Oil City, Pa. He was 86. Last May at the International Petroleum Exposition in Tulsa, he was honored as "a pioneer of pioneers" in the oil and gas industry.

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

N-Methyl-6 (1)-pyridone-3-carboxamide
2,1,3,4-Tetrazole-5-carboxylic acid
cis-Diphenylethylene oxide
4-Methoxyproline
1-Methylxanthine
Capsaicin
Cinchol
Kynurenine
L-Limonene
Gymnemic acid
6-Methylindole
1,4-Dibromo-2-butyne
3,5-Dihydroxycinnamic acid
Pyrazine-2,3-dicarboxylic acid
4-Methyltryptophane
Glycyrrhetinic acid
Amygdalin
delta-Tocopherol
Ornithuric acid
Protoanemonin

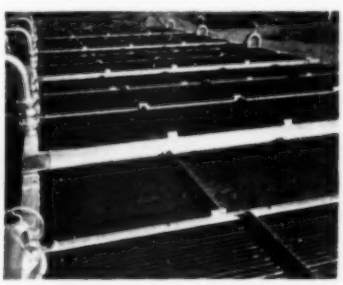
G-R fin-fan ...

from every point of view...

top value in **Air-Cooled Heat Exchangers**

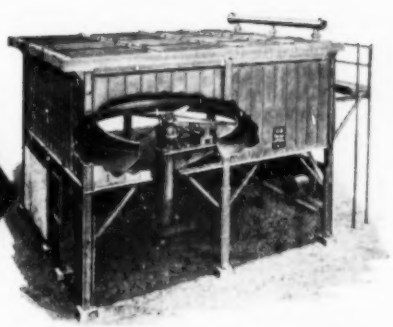
G-R **fin-fan** is top value in air-cooled heat exchangers because of the *experience* behind this unit. This experience includes 85 years of building heat transfer apparatus, 25 years of specializing on extended heat transfer surfaces as used in air-cooled exchangers, the operating records of hundreds of **fin-fan** installations all over the world, and the results of thorough tests on every element of the unit.

FROM ABOVE



The K-Fin Sections which form the heat transfer surface are used only in the G-R **fin-fan**. Many millions of square feet of this exclusive helically-finned surface are being used in more types of air-cooled services than any other design.

FROM THE SIDE



The strong reinforced construction is built to withstand wind pressures of more than 40 lbs. per sq. ft. The pre-fabricated, pre-drilled structure is specifically designed for speed and convenience of erection and connection to additional units.

FROM BELOW

Drive mechanism for G-R **fin-fan**. Note the mounting of driving motor and gear reducer, the powerful fan of proven performance, and the smooth bell ring for maximum aerodynamic efficiency.

THE GRISCOM-RUSSELL CO., MASSILLON, OHIO

GR-324A

What's Happening in the Industry . . .

PAD Relaxes Drive for New Alkylation Capacity

Because potential supplies of alkylate are close to meeting expected essential demands in an emergency, PAD is no longer pressing refiners to install new alkylation facilities, Deputy Petroleum Administrator Joseph A. LaFortune said last month.

While the 30,000 barrels per day expansion goal for alkylate which was set some time ago is being retained, attainment of the goal by a specified deadline date will not be pushed. PAD will continue to recommend accelerated tax amortization for the installation of new alkylation facilities wherever they can be justified. The Armed Services Petroleum Purchasing Agency will continue negotiations with a number of refiners for construction of new facilities under the available facilities contract arrangement.

Under these contracts, the government either guarantees a refiner a complete payoff of his investment in alkylation facilities within five years, provided certain of the optional contract provisions are met, or reimburses the refiner for his actual costs of construction as the plant is being built.

The other agencies of the government involved have agreed to the relaxation in the drive for new alkylation capacity.

The decision not to push the campaign for new facilities so strongly as in the past results from the recent PAD survey of the industry which revealed that there is substantially more alkylation capacity available and firmly planned to meet emergency conditions than had previously been known. These increases in capacity account for about 22,000 barrels per day of the 30,000 barrel goal.

Courtney Brown to Become Dean at Columbia University

Dr. Courtney C. Brown, assistant to the board chairman at Standard Oil Company (New Jersey), and a director of Esso Standard Oil Company, has been appointed dean of the Graduate School of Business at Columbia University. He will remain with Standard until the end of the year, assuming his duties at Columbia February 1. He has been with Standard since 1946.

Nichols Gets Appointment As Encoa Division Head

C. H. Nichols, a licensed professional engineer with 20 years of experience in the chemical and pharmaceutical fields, has been appointed head of Engineering Corporation of America's Chemical Engineering Process Design division.

Standard-Vacuum Adds Christensen to Staff

James A. Christensen has joined Standard-Vacuum Oil Company as assistant manager of its Economic Coordination department at New York, following 25 years service with Esso Standard Oil Company.

Christensen

Christensen has been head of the economic and long-range planning section of Esso Standard's Technical Service division at Linden, N. J., for the past six years. His oil industry career began in 1928 as a laboratory employe at Esso's Eagle Works in Jersey City. He was transferred eight years later to that company's Bayway refinery. He joined the Technical Service division in 1938, becoming an assistant section head in 1946.

Olsen Elected President of Lubricating Grease Group

G. A. (Fred) Olsen, president of Sunland Refining Corporation, of Fresno, Calif., has been elected to succeed W. W. Albright, Standard Oil Company (Indiana), as president of the National Lubricating Grease Institute. His election came at the Institute's 21st annual meeting, recently held in Chicago.

Long active in the National Lubricating Grease Institute, Olsen has served on its board of directors for the past three years. He was a co-founder of Sunland Refining 30 years ago in Fresno.

Texas A & M Schedules Instrumentation Symposium

The 1954 Symposium on "Instrumentation for Process Industries," presented by the Schol of Engineering, Chemical Engineering department, A & M College of Texas, will be held January 27 through 29, 1954.

The 1954 Symposium, ninth in a series designed to lead to an "improved understanding of the principles and practice of instrumentation," will give particular attention to new developments. Talks will be directed toward all engineers whose work requires knowledge of instrumentation.

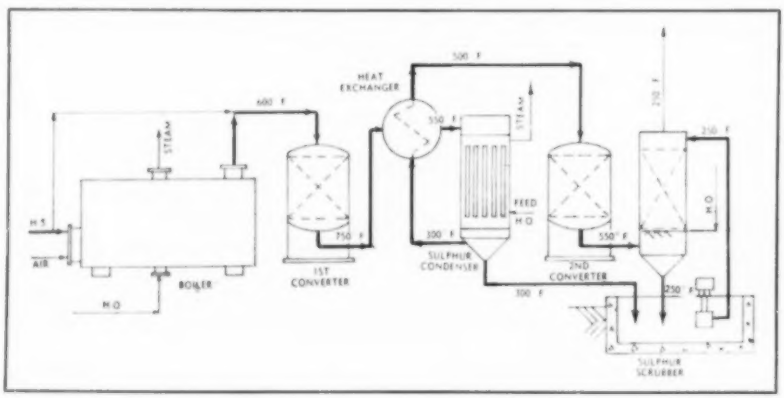
Any person interested in the subject is invited to attend. Registration fee is $8.

PAD Survey Shows Big Small Refiners Expansion

According to a PAD summary of rapid tax write-off certificates approved since its expansion program started, catalytic cracking and catalytic reforming capacities by small refiners have shown a big increase. Cat cracking capacity of small refiners will have increased from 36,000 barrels a day in 1951 to an estimated 205,000 barrels a day by January 1, 1956. Reforming capacity will be increased from 1500 barrels a day to 49,000 barrels a day over the same period. (Figures for 1956 were based on the assumption that projects for which certificates have been issued will have been built by that time.)

Pan American Executive Dies in Houston at 59

Leonard M. Wilson, secretary of Pan American Petroleum & Transport Company and its affiliates, including Amer-



Errata—We wish to call attention to an error which appeared on page 182 of the November Petrochemical Process Issue. The flowsheet used in connection with The Girdler Company Sulfur Recovery Process is not the correct one. The correct flowsheet for this process appears herewith.

Like Money in Your Pocket!

The National Safety Council estimates the total annual cost of on-the-job accidents at two and a half BILLION dollars, of which about half goes for visible costs such as medical expenses, insurance costs and wage losses.

The other half goes for indirect costs such as production delays, value of damaged equipment and materials, and time losses of workers not involved in the accidents.

LOWER RATES • BIGGER DIVIDENDS

When you reduce accidents you help reduce accident costs. These reductions are reflected in the rates you have to pay for Workmen's Compensation Insurance. And, when you insure with the Texas Employers' Insurance Association, these reductions are reflected in the dividends you receive. Yes, cutting accidents is like putting money in your pocket. Why not start an accident prevention program now?

Accident PREVENTION *Pays*

Largest Writer of WORKMEN'S COMPENSATION INSURANCE *in Texas*

HOMER R. MITCHELL, *Chairman of the Board* A. F. ALLEN, *President*

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TEXAS EMPLOYERS INSURANCE ASSOCIATION
HOME OFFICE - DALLAS, TEXAS

QUESTION — A manufacturing process is powered by a 8000 K. W. turbine. For the most economical operation, water used in the process should be cooled from 105° F to 85° F, at 77° F wet bulb temperature. How much will this cooling tower cost?

ANSWER — A tower with a .78 water-air ratio is needed and will cost about $50,000.

QUESTION — How much can be saved if the tower cools from 107° F to 87° F at 77° F wet bulb temperature — 2° F higher temperature?

ANSWER — This tower will require a .95 water-air ratio, and will cost only .78/.95 x $50,000, or $41,000, a saving of $9000 in initial cost.

QUESTION — Then, isn't the second tower the better buy?

ANSWER — Before answering, let's examine your operating cost. The steam needed to operate a 8000 K. W. turbine costs about $750 per day. The 2° F overage on the second tower will increase your fuel consumption 3%, so your operating cost will be increased $22.50 per day, or $6750 per 300 day year. In ten years, your operating cost will be increased $67,500, or more than the initial cost of the first tower. The answer is definitely, No!

When considering a new cooling tower, get the best engineering advice possible — consult a WCEC engineer. And after your tower is built, installed, and in operation, be sure that it meets your specifications.

BE SURE WITH WATER COOLING EQUIPMENT COMPANY

Manufacturers of various types and sizes of mechanical draft and atmospheric cooling towers.

SEE OUR CATALOG IN SWEET'S FILE

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W C E C

What's Happening. . .

ican Oil Company, died last month in Houston. He was 59.

Wilson joined Pan American in 1929 as a clerk. From 1935 to 1941 he was New York property tax representative for the company. He was elected secretary in 1941.

McBride to Reorganize And Expand Interests

A general reorganization and oil-gas development has been announced by H. L. McBride, president of McBride Refining Company, San Antonio, Texas. The program includes:

McBride

1. Consolidation of all the various McBride properties, concerns and holdings into one general operating corporation in the interest of streamling management and control. The new corporation will be called McBride Oil & Gas Corporation.

2. A $2.5 million intensified and expanded development of oil and gas properties now under development by the McBride interests through an intensive drilling program in the immediate future.

3. A $2.5 million plant facility expansion at McBride's Port Fuel Company, of Port Brownsville, Texas, to increase the 7500 barrels a day of gasolines, heating oils and other fuels processed from crude to 20,000 barrels.

4. Financing of the major plant expansion-reorganization-development program through a program of stock issuance.

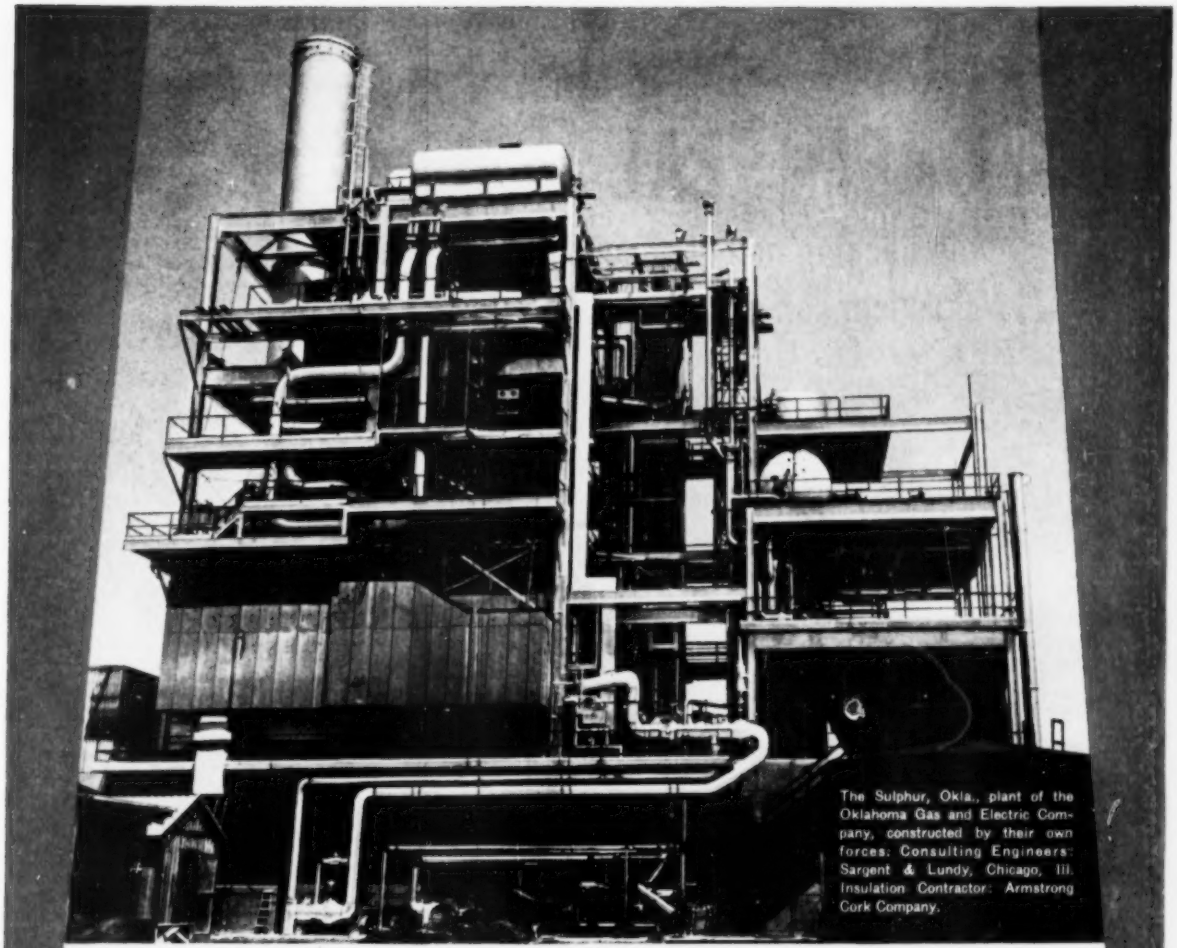
Companies to be merged into the new McBride Oil & Gas Corporation are McBride Refining Company, Inc., with a refinery at La Blanca, Texas; Port Fuel Company; McBride Transport Company, Edinburg, Texas; La Blanca Power, Light & Ice Company, La Blanca; and McBride Oil Company.

Royalite Signs Agreement To License UOP Processes

Royalite Products, Ltd., subsidiary of Royalite Oil Company, Ltd., has signed a license agreement with Universal Oil Products Company, Chicago, for use of UOP's fluid catalytic cracking process, catalytic polymerization process, and the UOP gas concentration unit. The licensed processes and equipment will be used at the new 5000-barrel-a-day refinery being constructed by Royalite Products at Kamloops, B. C. The cost will be in excess of $2 million.

Tide Water Transfers Ambrose to San Francisco

Oliver S. Ambrose has been placed in charge of Tide Water Associated Oil Company's Economics and Petroleum Analysis department, headquartered in



The Sulphur, Okla., plant of the Oklahoma Gas and Electric Company, constructed by their own forces. Consulting Engineers: Sargent & Lundy, Chicago, Ill. Insulation Contractor: Armstrong Cork Company.

They chose "Featherweight"® 85% MAGNESIA

TO INSULATE HEATERS, EVAPORATORS & STORAGE TANKS

To make their Sulphur, Okla., plant as modern and efficient as possible, Oklahoma Gas and Electric Company sought a modern, efficient insulation material. They found it in "Featherweight" 85% Magnesia, and used it extensively throughout the plant to insulate heaters, evaporators, storage tanks, and other equipment.

"Featherweight" 85% Magnesia is effective where temperatures do not exceed 600° F. Used in combination with K&M Hy-Temp Insulation (diatomaceous silica) its range is extended to 1900° F.

Hy-Temp is applied directly to the hot surface, and "Featherweight" is used as the second layer. The two layers are fitted with staggered vertical and horizontal joints—thus eliminating heat loss which occurs on single layer installations when the expansion of hot piping and equipment causes joints to open.

This K&M combination insulation will last the life of the equipment it serves, will withstand moisture, vibration, alternate heating and cooling, wetting and drying. Both materials are supplied in a variety of forms and thicknesses.

Your K&M distributor is an experienced applicator who will gladly give you more information about these heat-saving, money-saving K&M insulations. Or write directly to us.

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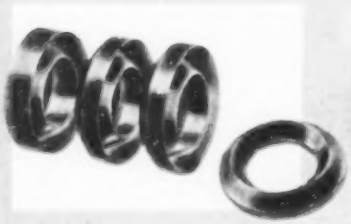
the packing no petroleum chemical can attack . . .

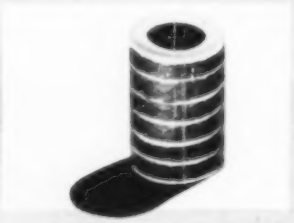
Attention—pump and valve builders and users! End troublesome packing problems for good, with Chemiseal (made of TEFLON*) Packing.

Chemically inert, there is no need to change packing for different crudes or operating conditions.

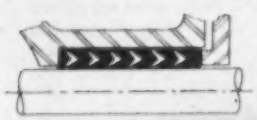
Chemiseal is also highly resistant to abrasion, is serviceable from —110°F. to 500°F., stands up where other packings fail rapidly.

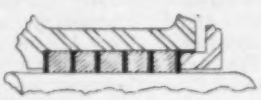


Chemiseal Valve Packing No. 810-V provides necessary seal at low gland pressure, reducing torque required to operate valve. Supplied in quantity or in sets with square-end Teflon adaptors. Write for catalogs Nos. 711 and 810-V.



Chemiseal Pump Packing No. 711, for rotating or reciprocating shafts, provides a low-friction, 2-way seal that not only prevents axial seepage, but seals against shaft and stuffing box as well. Sets supplied for specific requirements.





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FABRICATORS OF "TEFLON", "KEL-F" AND OTHER FLUOROCARBON PLASTICS

CAMDEN 1, NEW JERSEY

*duPont's trademark for its tetrafluoroethylene resin

What's Happening. . .

San Francisco. Ambrose has been transferred from the company's New York office.

Starting with Tide Water Associated as a construction engineer at its Drumright, Okla., refinery in 1920, Ambrose later served there in the Operating department of Tidal Refining Company, a subsidiary, from 1921 to 1928. In 1928 he was made a petroleum analyst in the New York office.

Pan American Announces Promotions at Texas City

Promotions of W. A. Sullender to assistant general superintendent (Operating), R. G. Anderson to operating superintendent, and R. F. Stahl to associate director, Research and Development department, have been announced by Pan American Refining Corporation, Texas City, Texas.

Stahl Anderson

Sullender

Sullender began in Pan Am's Engineering department in 1935, moving to Operations as assistant department head five years later. He became head of the Catalytic & Distillation department in 1947. At the time of his promotion he was department supervisor in the Catalytic Cracking department.

Starting with Pan Am in 1942 Anderson advanced to assistant department head of the Light Oils department by 1948. He became assistant department head of the Catalytic & Distillation department in 1950, and in January, 1952, assumed the same position in the Coordination & Economics department. In July of last year he became department supervisor (C&E) Operations, which position he held prior to his promotion.

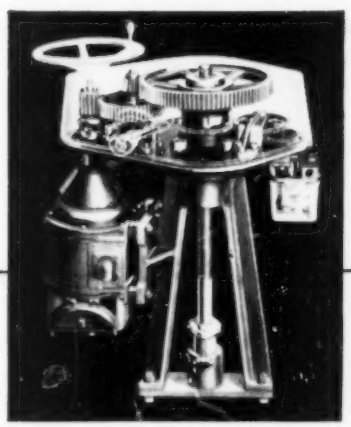
Stahl began his association with the Pan American Research & Development department in 1942 as a chemical engineer. He became successfully group leader; section head, Technical Service; and section head, Economics. Prior to his promotion he was assistant director of Research, Development division.

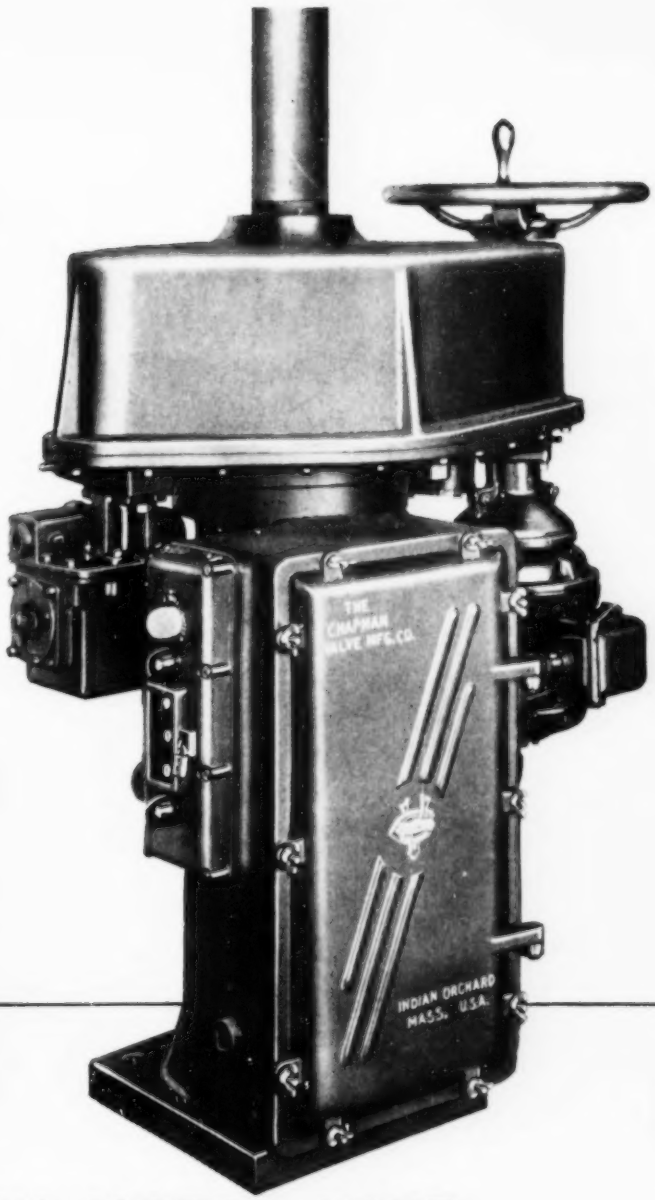
Other promotions in the Research & Development department are as follows:

R. L. Meuleners to assistant director, with the additional responsibility of supervision of the Development and Tech-

SMART OPERATOR

for Valves, Gates and Floorstands





CHAPMAN'S MOTOR UNIT

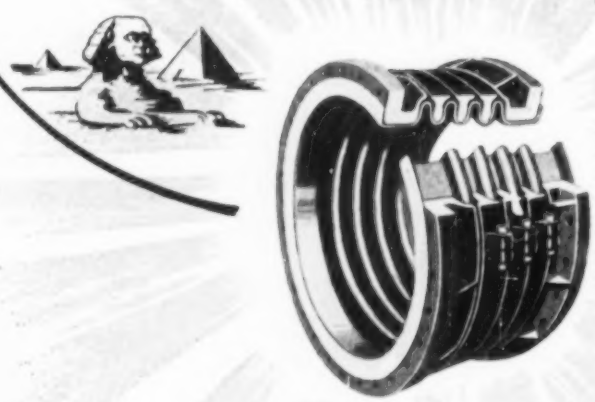
Instant control of valves and large sluice gates at the touch of a button . . . that's what you get with Chapman Motor Units on the job. Completely housed and thoroughly dust and weather proof, these units are built "to take it" for years, on the roughest service. They're designed for simplicity and extreme ruggedness, as shown by internal view above.

Chapman Motor Operated Floorstands are delivered to the job with all internal wiring complete, so all the wiring to be done is to bring the power leads into the connection box... saving time and money in installation and assuring proper operation. Write for Catalog No. 50.

The Chapman Valve Manufacturing Co.

INDIAN ORCHARD, MASSACHUSETTS

Designed for
DURABILITY
as well as Flexibility



DURABILITY is designed into the Badger Directed-Flexing, Self-Equalizing Joints:

1 each corrugation is designed with the proper depth for its diameter; each diameter is gauged to its proper traverse

2 each corrugation—and it's the Badger ***all curve*** corrugation—is shaped to flex by Directed Flexing using matching shaped equalizing rings to guide and control the flexing movement. The corrugation wraps and unwraps itself, using the rings as the bearing surface, distributing the flexing stresses evenly over all areas of each of the all-curve corrugations.

3 each corrugation is progressively controlled and limited to its proper flexing traverse

4 the corrugations are formed from a single metal tube of suitable length by a special forming process which minimizes forming stresses in the metal

5 every joint is scientifically heat-treated at each of several key steps in its manufacture

The many thousands of Badger Directed-Flexing, Self-Equalizing Expansion Joints in service now for many years are in themselves testimonials as to their durability. They will serve you equally well. With a wide range of sizes in either flanged or welding end design, with a choice of several metals, with facilities for designing special joints, why not let our expansion joint specialists take care of your requirements?

BADGER MANUFACTURING COMPANY

Original and Sole Manufacturer of Badger Expansion Joints

230 BENT STREET • CAMBRIDGE • MASS.

What's Happening. . .

nical Service division; W. F. Curran from acting section head to section head and transferred to the Technical Service division; D. B. Meyer to section head, Process Design section; Dr. J. F. Horner to group leader in the Process Design section.

Honorary API Directors Named for First Time

For the first time honorary members have been named to the API board of directors. All 11 of those named have retired from the board after ten or more years of service. They are: H. D. Collier, Standard Oil Company of California; J. Frank Drake, Gulf Oil Corporation; Wirt Franklin, Oklahoma City; Alexander Fraser, Shell Oil Company; H. T. Klein, The Texas Company; J. Howard Pew, Sun Oil Company; W. S. S. Rodgers, The Texas Company; W. C. Teagle, Standard Oil Company (New Jersey); O. D. Donnell, The Ohio Oil Company; Robert H. Colley, The Atlantic Refining Company; and John R. Suman, Standard Oil Company (New Jersey).

At the meeting at which the honorary members were designated, the directors designated Chicago as the site for the 1956 annual meeting. Next year's convention will be held in Chicago, while the 1955 annual meeting will be in San Francisco.

Maintenance Problems Will Get Refiners' Attention

Problems in refinery maintenance are slated to be discussed at the 19th midyear meeting of the API Division of Refining in Houston next May 10-13. Three full sessions on the second day of the meeting will be devoted to the subject, with morning and afternoon programs covering typical refinery maintenance, and an evening session on tank failures.

The complete Houston meeting will consist of 12 sessions on nine subjects. In addition to maintenance, these include petrochemicals, fractionation, processes, corrosion, waste disposal, training, motor fuel (in which the problem of preignition is to be stressed), and analytical research.

Newton Cites High Cost of Corrosion to Oil Refiners

Corrosion may be costing the oil refiners as much as a quarter of a billion dollars a year, John W. Newton, vice president of the Division of Refining of the API, stated last month. The refining executive said that the preliminary figure is a result of a study being made by the API Subcommittee on Corrosion.

Newton said that current records do not provide better than an approximate loss figure because many losses are indirect and others are concealed frequently in the statistics of general maintenance. One of the objectives of the subcommittee is to work toward a reasonable procedure for estimating the

Meet the man you can call with confidence to solve your thermal insulation problems

To insulate outdoor tanks with complete weather protection, these skilled J-M applicators follow a specification developed by Johns-Manville. Here they are fastening J-M Asbestocite* Sheets over J-M Zerolite* Insulation. J-M 85% Magnesia Insulation is also widely used for this type of equipment

He is your J-M Insulation Contractor... the man with the world's most complete insulation engineering service

"Insulation is no better than the man who applies it." Today, with rising fuel and maintenance costs, it is especially important to place your insulation job in skilled hands. The scientific application of J-M quality insulations by J-M Insulation Contractors will assure you of the maximum return on your insulation investment for years to come. Moreover, you get undivided responsibility for *all* your insulation requirements.

1. You get dependable materials—Johns-Manville manufactures a complete line of insulations for every service temperature from minus 400F to plus 3000F. From them your J-M Insulation Contractor can select the right insulation for the most dependable service on your job. To develop new and improved insulation materials Johns-Manville maintains the J-M Research Center—largest laboratory of its kind in the world.

2. You get dependable engineering—For 95 years Johns-Manville has been accumulating insulation engineering experience. J-M Insulation Engineers are called upon to solve insulation problems of every type and magnitude, in every industry. Since your J-M Insulation Contractor works closely with J-M Insulation Engineers, he brings to *every* job a high degree of training, skill and experience.

3. You get dependable application—Johns-Manville has set up a nationwide organization of J-M Insulation Contractors to serve you. These Contractors maintain staffs of insulation engineers as well as skilled mechanics thoroughly trained in J-M's proved application methods. You can have absolute confidence in their ability to apply J-M insulations correctly for trouble-free performance.

For further information and the name of your J-M Insulation Contractor, write Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ont.

*Reg. U. S. Pat. Off.

Johns-Manville *FIRST IN* INSULATION

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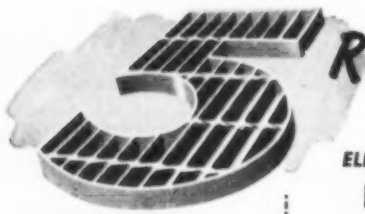

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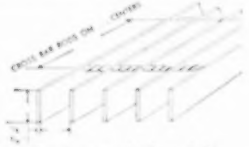

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What's Happening. . .

NAS Committee Reports AD-X2 Without Merit

The Committee on Battery Additives of the National Academy of Sciences has issued its report on the controversial additive AD-X2. Conclusion of the report: AD-X2 is without merit.

"Report of the Committee on Battery Additives of the National Academy of Sciences," made public last month by Secretary of Commerce Sinclair Weeks, is the result of a request by Weeks that a committee be appointed to appraise the quality of the work performed by the National Bureau of Standards in relation to battery additive AD-X2.

On April 17 of this year Weeks requested Dr. Detlev W. Bronk, president of the National Academy of Sciences, to appoint the committee. The Committee on Battery Additives of the National Academy of Sciences was under the chairmanship of Dr. Zay Jeffries, vice president (retired), General Electric Company, Chemical division.

Conclusions of the committee, as stated in the report, are that the quality of the work of the Bureau in the field of lead acid storage battery testings "is excellent" and "is better now than at any time in the past."

Sun Refinery Provides For Waste Water Purification

For what is believed to be the first time, a refinery has provided a water purification system for the protection of a river from pollution. The 15,000-barrel-a-day Sarnia, Ontario, refinery of Sun Oil Company, Ltd., which went on stream last month, has included a commercial installation of bacterial oxidation for the removal of phenol or other organic waste material.

The installation, which has been adopted by the API as a standard for the industry, comprises three separate systems for the preliminary segregation and treatment of different types of waste water from the refinery.

The initial segregation of waste water stream is a feature necessary for the economical installation of the bacterial oxidation process. Without such preliminary segregation, such a process would require a lengthy installation period and consequently greater expense.

Although Sun is the first petroleum refiner to install this advanced process, it has been proved successfully in operation by other industries and in large cities.

Sun's first Canadian refinery is located on a 196-acre site in the heart of Sarnia's progressive Chemical Valley, on the east bank of the St. Clair River in western Ontario. It was built by Catalytic Construction of Canada, Ltd.

Now in operation is a new type combination topping and Houdriflow catalytic cracking unit. The latter has a rated capacity of 11,000 barrels a day. A Houdry catalytic reformer is under construction with completion scheduled for February of next year.

Gordon R. Henderson, formerly chief

LAGONDA

delivers the goods -fast!

TUBES SWEPT CLEAR of the toughest coke with the irresistable speed of a bulldozer through brush. Through tube after tube, without let-down, the self-feeding cutter head smashes the coke and shoves it out, backed by the powerful drive of the famous Lagonda 1100 Series motor with its ball thrust bearings front and rear, and its exclusive front end lubrication. Here's a combination that is both enduring and fast.

Fast, too, in getting to the job. Let a customer tell what he thinks of Lagonda deliveries: "This is a note of appreciation for the very fine service you rendered us on our recent order. It was received yesterday, well ahead of schedule. Thanks a lot."

When you need tube cleaning, you want *speed.* Call your local Elliott-Lagonda representative, or Elliott Company, Springfield, Ohio.

ELLIOTT Company

LAGONDA DIVISION, SPRINGFIELD, OHIO

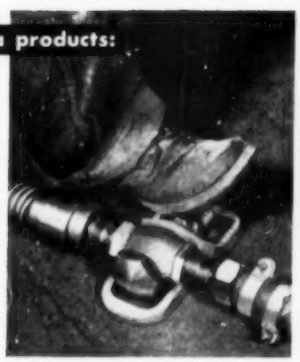
HERE'S VALUABLE TUBE CLEANING DATA.

Bulletin Y-34 is crammed with facts on cutting down time in cleaning still tubes. On request.

Y3-6

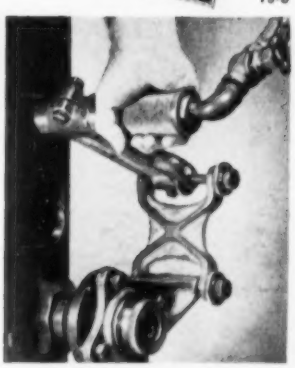
Some other Lagonda products:

AUTOMATIC SIGHT FEED LUBRICATOR for pressure service. When pressure is on, lubrication starts. When pressure is shut off, lubrication stops. Simple and positive.



FOOT-OPERATED THROTTLE VALVE enables operator to handle tube cleaner with both hands, controlling pressure with his foot, like an auto accelerator.

CATALYST CLEANER. Removes spent catalyst from tubes, without permitting its escape. Also good in removing fly ash from the tubes of air preheaters.



HANDHOLE SEAT GRINDER. A precision tool for grinding handhole seats flat. Can save its cost on one job. Driven by air motor (electric motor optional).

What's Happening. . .

engineer of Polymer Corporation, Sarnia, is manager of the new refinery. Frank W. Bowen, formerly with Sun's Toledo refinery is superintendent, and Fred A. Bain is chief refiner.

Aurora to Lease, Operate All Old Dutch Facilities

Aurora Gasoline Company, Detroit, has completed negotiations with Old Dutch Refining Company, Muskegon, Mich., whereby Aurora will lease and operate all Old Dutch facilities for ten years from November 15, 1953.

The facilities involved consist of a refinery at Muskegon with a capacity of 10,000 barrels a day of crude oil. The addition will increase Aurora's refining capacity from its present 40,000 barrels a day of crude to 50,000 barrels.

Conoco Promotes Two in Petrochemical Department

Appointment of two men to new positions in Continental Oil Company's Petrochemical department has been announced. They are: K. R. Gerhart, sales service laboratory supervisor at Conoco's Baltimore petrochemical plant, promoted to assistant superintendent of the company's Chicago petrochemical plant; R. L. Kylander, Ponca City, Okla., process engineer, promoted to process-sales service engineer at the Baltimore petrochemical plant.

Department Appointments Made by Indiana Standard

Standard Oil Company (Indiana) has made several appointments to advanced positions in its Manufacturing and Research departments, effective January 1, 1954.

R. M. Cash, general superintendent of the company's Sugar Creek, Mo., refinery, will become manager of the Operations and Cost Control division in the Manufacturing department general office at Chicago, replacing F. Cushing Smith, who will be transferred to the Whiting, Ind., refinery as general foreman in the light oils division on special assignment.

P. C. Livesay, manager of the Projects, Capital Expenditures, and Miscellaneous Contracts division in the Manufacturing department general office at Chicago, will succeed Cash as general superintendent of the Sugar Creek refinery. Charles F. Smith, assistant general superintendent of the Whiting refinery, will replace Livesay.

Appointment was also announced of Dr. R. N. Giles, director of technical service in the Research department general office at Chicago, as general superintendent of Standard's newest refinery, now under construction at Mandan, N. D.

William L. Webb, administrative director of the Whiting research laboratories, will succeed Dr. Giles. Dr. C. R. Harte, superintendent of technical service at Whiting, has been appointed to the new position of technical service coordinator in the Research department general office at Chicago.

R. F. Baldaste, assistant administrative director, will be advanced to administrative director of the Whiting research laboratories, and W. F. Meehan, assistant superintendent of technical service, will be promoted to superintendent. R. C. Mallatt, chief chemist, will become assistant superintendent of technical service, and Walter V. Cropper, assistant chief chemist, will be advanced to chief chemist.

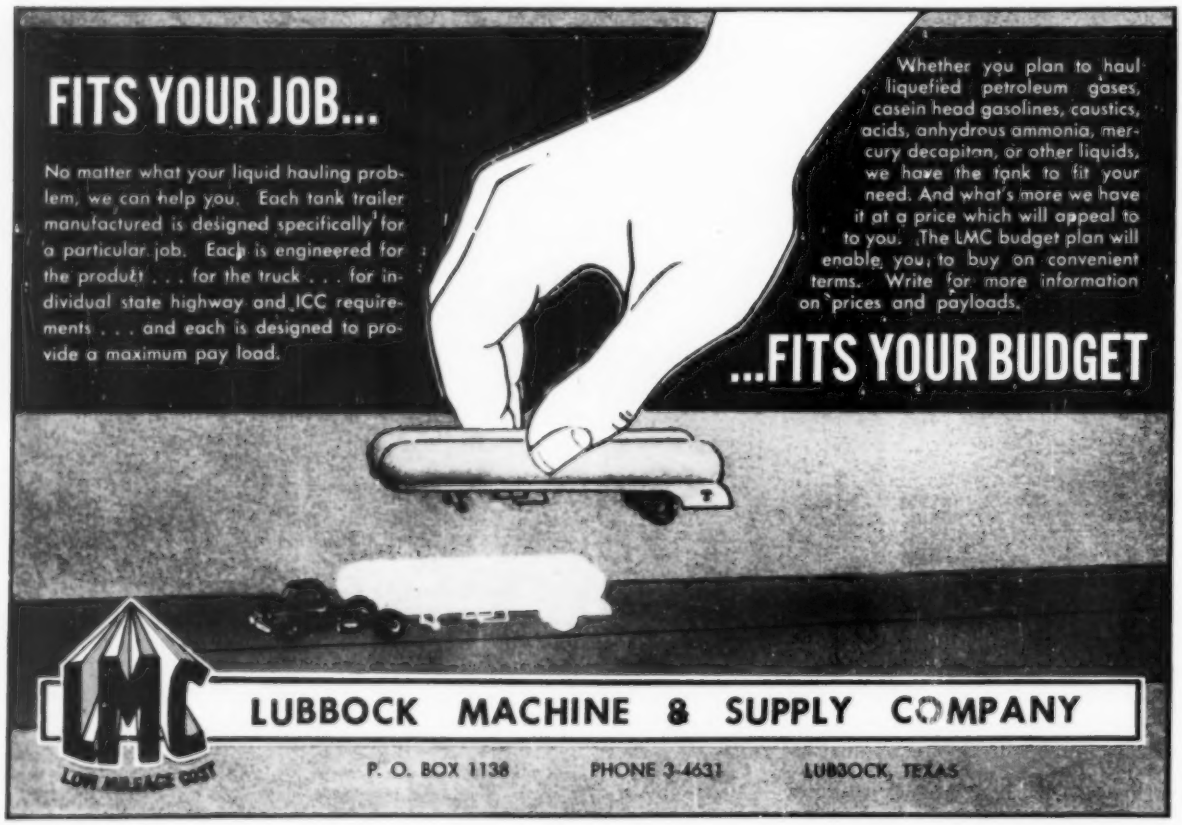
McKay Says Cooperation Better Than Ownership

The government can save money and get more done in such fields as synthetic fuels through cooperation with industry instead of through government-owned operations, Interior Secretary McKay said last month.

McKay cited the Louisiana, Mo., synthetic fuels plant as an example. He said demonstration work there had proved that basic research was sound, but that it had reached the point of diminishing return and was costing the government $10,000 daily. Therefore, he said, the plant was put up for sale so private industry could develop the commercial possibilities. He emphasized that he felt that the government's role in basic research should be continued but, when the research is done, it is time for the government to move over and let industry carry on.

Boyer Returns to Esso From Atomic Energy Post

Marion W. Boyer, formerly general manager of the U. S. Atomic Energy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CHEMICAL PROCESS NEWS

PUBLISHED BY CHEMICAL PROCESS DIVISION, THE M. W. KELLOGG COMPANY — DECEMBER 1953

NOTES ON

AMMONIA

The cost of a plant for the production of synthetic ammonia is greatly affected by the composition of the feed gas.

* * *

Conventionally, if natural gas is the feed it must undergo several preparatory steps to produce a suitable mixture for the ammonia synthesis. Reforming or partial combustion must be followed with CO shift and then absorption purification to remove CO_2 and unconverted CO. On the other hand, if hydrogen-rich gas is the charge the process requirements are greatly simplified. The feed is chilled to low temperature and subjected to liquid nitrogen washing to remove impurities. Ammonia synthesis is accomplished by the same method with either feed stock.

* * *

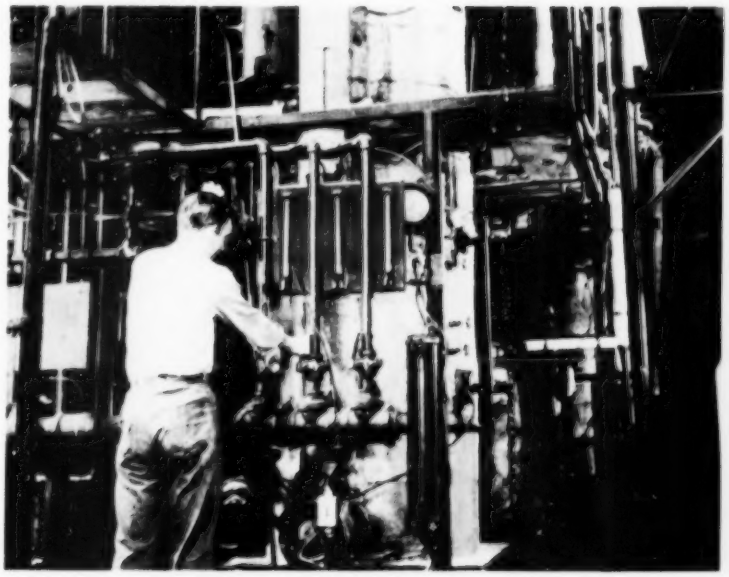
Since the largest single item of cost in the production of ammonia is the charge for plant depreciation, (about 20% greater than per-ton-direct-operating-cost in a natural gas feed plant) the extent of the equipment required to prepare synthesis gas has a major effect on total production cost.

* * *

Economic analyses of processes involving both feeds show that the payout time for plant utilizing hydrogen-rich gas is in the neighborhood of three years, and that employing natural gas is less than five years.

* * *

Thus there is a great economic incentive for anyone with hydrogen-rich gas or by-product hydrogen available to enter the fields of ammonia production.



Ethylene Pilot Plant Studies Disclose Flexibility of Unique Pyrolysis Method

In the pilot plant shown in the illustration Kellogg is currently carrying on extensive studies of the adaptability of its unique pyrolysis process to the production of high purity ethylene from feed stocks other than naphtha—the charge stock for which the process was originally developed.

The pilot plant runs have already proved that the method can be employed successfully on ethane, propane and heavier materials without production of the large amounts of coke normally encountered in conventional processes.

This low coke production had been predicted on the basis of commercial operating reports from an ethylene plant which Kellogg designed and erected in England for the pyrolysis of naphtha.

Whereas conventional pyrolysis furnaces usually average only a few weeks on stream before being shut down for coke removal, the English plant has remained in continuous operation for 12-month periods. During these times it was operated with sufficient severity to convert 55 to 60 wt.% of the naphtha to ethylene and other gaseous hydrocarbons.

The unique fractionation system of the English plant has also proved highly efficient as demonstrated by the fact that the plant produces 99.9% pure ethylene.

In addition to producing high quality products over extended periods, the plant has attained maximum economy of the heat required for pyrolysis. A novel design in the quenching system which follows the pyrolysis step, plus the use of low-level heat by the absorption refrigeration system, provide major savings through recovering most of the heat used in cracking.

Technician in Kellogg's Analytical Laboratories determines olefin yields from pyrolysis pilot plant run

(SEE REVERSE SIDE)

CONTINUED FROM PRECEDING PAGE

Work Well Underway On Fluid Phthalic Plant in England

Work is well underway on a Fluid phthalic anhydride plant now under construction in England. It is scheduled for completion by the Spring of 1954.

Several design improvements have been developed since the first such plant was built in the U. S. and they are being incorporated in the new plant.

Most important is the re-design of the condensing system which not only decreases capital investment but also improves operating conditions. It precludes, for example, any need for operators to come in direct contact with the phthalic or its fumes.

A second unit is also being built, this one on the Continent. Between the two they will produce about 50 million pounds of phthalic anhydride annually. The product in this process is produced by the oxidation of naphthalene in the presence of a fluidized solid catalyst.

NEW ALCOHOL PLANT . . . is well on the way toward completion in the Mid-West. Employing the basic OXO process, it will produce iso-octyl alcohol. This view was taken looking northeast over the east end of the control room to the main fractionating tower group. Shown in the background are alcohol, alcohol re-run and aldehyde columns.

Two New Process Bulletins Issued

Bulletin describes advantages of new Montecatini "Ammonia-Saturated" Urea Process now licensed exclusively in the United States by The M. W. Kellogg Company.

Investments for ammonia plants employing either natural or hydrogen-rich gas are shown in convenient form, as are utilities and other operating costs.

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Typical Current Kellogg Chemical Plant Contracts in the fields of—

- Ethylene
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In this patented design of The Standard Oil Company of Ohio, the desired flame characteristics were obtained by installing air inspirators. An annular ring atop the tip prevents back drafts from forcing flame down the side of the stack. And refractory cement is used to line the ring and the inside section of the stack tip.

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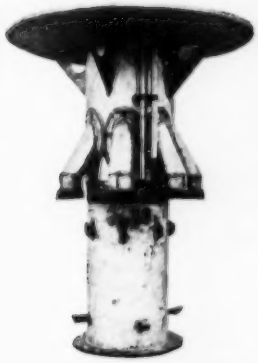

THIS INCONEL flare tip, designed by The Standard Oil Company of Ohio, lasted 6 times as long as any tip previously used. The savings in steeple-jack labor charges alone amounted to $4,400 a year! (Firms licensed to manufacture and sell this design are: Fritz W. Glitsch & Sons, Inc., Dallas, Texas, and Western Supply Company, Tulsa, Oklahoma. Information regarding the licensing of this design may be obtained from The Standard Oil Company of Ohio.)

Inco Nickel Alloys

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Inconel... YOUR PARTNER IN PROGRESS

What's Happening. . .

Commission, has returned to Esso Standard Oil Company as vice president, director and member of the executive committee.

Following his resignation from the Esso Company in October, 1950, to assume the government position, Boyer coordinated the construction program of the Commission for three years. He joined Esso Standard in 1927 from the Massachusetts Institute of Technology, where he was an assistant and an associate in the Research Laboratory of Applied Chemistry. A former vice president and general manager of the Louisiana Manufacturing division, he was elected a director in 1945.

API Adds Haug to Staff Of Division of Refining

Eugene J. Haug has joined the American Petroleum Institute as an engineer in the Division of Refining. His work will be primarily concerned with projects of the committee on refining equipment.

For the past two years, Haug has been in business for himself, designing specialty equipment for use in catalytic cracking operations. Prior to that he was project engineer for The Lummus Company, where he worked on a variety of refinery design and construction problems. Earlier in his career, he had been with Chemical Construction Company, Arthur G. McKee Company, Gielow, Inc., and Dekom Shipbuilding Corporation.

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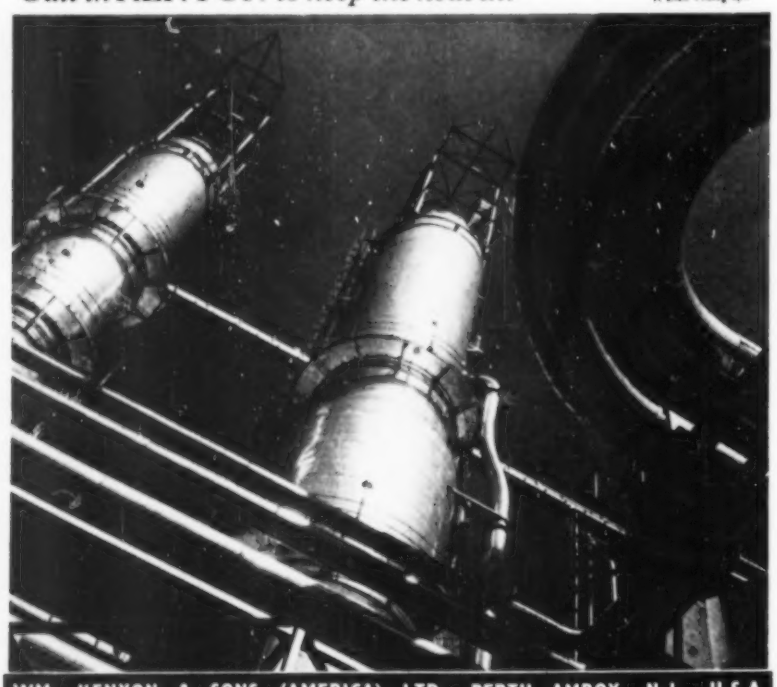

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AIChE Literature Award Given to W. R. Marshall

AIChE's eighteenth annual William H. Walker Award for distinguished contribution to chemical engineering literature goes this year to William Robert Marshall, Jr., professor of chemical engineering and associate dean of the College of Engineering, University of Wisconsin. Granted in memory of the late William H. Walker, pioneer in modern chemical engineering and professor of chemical engineering at Massachusetts Institute of Technology, the award was to have been presented to Dr. Marshall at the Awards Banquet during the Institute's Annual Meeting in St. Louis, December 15.

Dr. Marshall, a nationally known authority on drying, is to receive the award in recognition of his publication record over the years.

Other awards to have been presented at the Annual Meeting are the Professional Progress Award, sponsored by Celanese Corporation of America and administered by the AIChE, which goes to George Edward Holbrook, assistant director, Development department, E. I. du Pont de Nemours & Co., Wilmington, Del.; the Junior Member Award, given to LeRoy Alton Bromley, associate professor of chemical engineering, University of California, Berkeley, for outstanding papers published in *Chemical Engineering Progress*, major publication of AIChE, by a Junior member; and the A. McLaren White Award, granted to Raymond M. Cartier, whose paper was judged the best of those submitted in the annual student contest sponsored by AIChE.

Indiana Standard Promotes Anderson at Sugar Creek

Jack Anderson was recently promoted to general foreman, Process division, at the Sugar Creek, Mo., refinery of Standard Oil Company (Indiana). He is now in charge of all process units in the west plant area of the refinery which are: fluid catalytic cracking, vapor recovery, polymerization, combination crude and delayed coking.

Anderson previously held positions as project engineer and assistant general foreman, process division, with Standard, and was formerly with Cities Service Oil Company in Oklahoma City and Associated Refineries in Duncan, Okla.

Pan-Am Southern Makes Six Personnel Changes

Six personnel changes in its Manufacturing department have been announced by Pan-Am Southern Corporation. Changes are as follows:

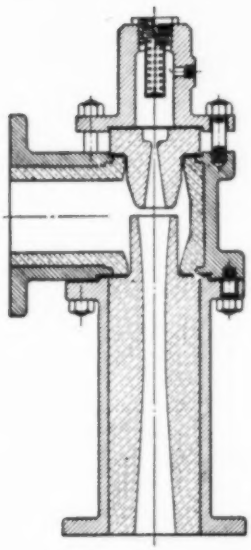
J. D. Walk, technical director, El Dorado, Ark., refinery, was named manager of technical service in the General Office Manufacturing department.

C. W. Peters, on leave for the past year with the PAD, has returned to Pan-Am and has been appointed economics director, Destrehan, La., refinery.

O. A. Fuchs, assistant superintendent, process, El Dorado, succeeds Walk as technical director.

C. M. Durham, assistant superintendent, utilities, El Dorado, was promoted

C-R EVACTORS



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What's Happening. . .

to superintendent, process.

E. S. Chelchowski, senior staff engineer, New Orleans, was appointed assistant superintendent, process, El Dorado.

R. F. Provine, assistant unit foreman, El Dorado, was appointed unit foreman, hydroformer, El Dorado.

Speakers Honor Ipatieff At Northwestern Ceremony

At the dedication last month of a new Super Pressures unit at Northwestern University, the late Prof. Vladimir N. Ipatieff was described as a man who dedicated himself to helping all mankind enjoy better living.

The dedication of the new unit of the Ipatieff Catalytic and High Pressure Laboratories at Northwestern, held on the campus at Evanston, Ill., was the highlight of a joint meeting of the Chicago section of the ACS and the Chemistry department of Northwestern.

David W. Harris, president of Universal Oil Products Company, with which Professor Ipatieff was associated for more than 20 years, gave the dedicatory address. Harris said, "The Ipatieff Super Pressure Laboratory will be an inspiration for all coming here to carry on the work of this man, who unselfishly shared his wisdom so that all humanity might benefit."

Sir Hugh S. Taylor, dean of Princeton University's graduate school, was the featured speaker, talking on "Fifty Years of Contact Catalysis." Prof. Robert K. Summerbell, former chairman of Northwestern's Chemistry department, discussed "Ipatieff at Northwestern."

The new Super Pressures unit, which took five years to plan, design and build, is the only one of its kind at a North American university. Undergraduate and graduate students, as well as scientists from all over the world, will have the opportunity to use the new unit to study and do research on the application of super pressures to catalytic reactions of organic compounds.

Union Oil Names Hartley Manager of New Division

Fred L. Hartley has been appointed manager of the new Commercial Development division established by Union Oil Company in its Research and Process department. The division has been organized to extend the commercial application and licensing of Union's research and process activities.

Hartley has been with Union Oil for 15 years as manufacturing process supervisor in charge of process design, and for the last three years has been general superintendent of operations at Union's Los Angeles refinery.

Cities Service Elects Heston Vice President

Election of J. F. Heston as vice president and director of Cities Service Oil Company (Del.), principal member company of the Cities Service system, has been announced. Heston, who has been coordinator of oil production for Cities Service in New York, will assume his

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- ***The Chemistry of the Non-Benzenoid Hydrocarbons***
  By Benjamin T. Brooks price $12.00
- ***Methods of Analysis of Fuels and Oils***
  By J. R. Campbell and W. Gibb price $4.00
- ***Chemical Engineers' Handbook***
  By John H. Perry price $17.00
- ***Correction Tables for Petroleum Oils***
  By O. H. Bardill price $3.50
- ***Handbook of Dangerous Materials***
  By N. Irving Sax, W. W. Schultz and M. J. O'Herin price $15.00
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  By Ovid Eshbach price $10.00

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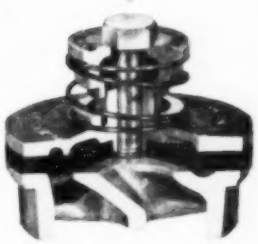

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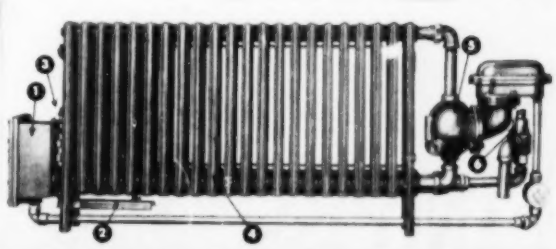

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What's Happening. . .

new duties immediately in the Bartlesville, Okla. headquarters of the oil company.

Mangelsdorf to Head Esso Manufacturing Department

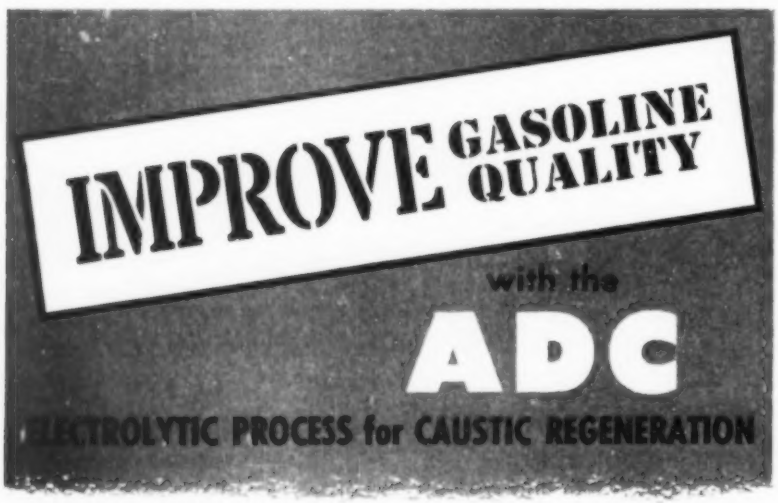
Harold G. Mangelsdorf, manager of Esso Standard Oil Company's East Coast manufacturing operations, has been appointed manager of Esso's Manufacturing department. He succeeds William Naden, director and vice president, who was designated primary contact director for Manufacturing.

Mangelsdorf joined Esso Standard in 1934 at its Baton Rouge, La., refinery.

Toledo Chemical Engineers Elect Thober President

Herbert C. Thober, chief chemical engineer for Sun Oil Company, Toledo, Ohio, has been elected president of the Toledo Society of Chemical Engineers to serve for 1954. The Society also voted to assist the University of Toledo.

Other elected officers: Kenneth Meiser, Barrett Company, vice president; Lawrence Larsen, Sun Oil Company, secretary-treasurer; and Walter Burg, University of Toledo; George Irwin, Surface Combustion Company; A. W. Kassay, Barrett Company; William Williams, Maumee Development Company; R. R. Beckham, Libbey-Owens-Ford Glass Company; and Joseph R. Scalzo, Sun Oil, all named to the executive committee.



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Humble Promotes Three In Divisions at Baytown

Humble Oil & Refining Company has announced three promotions in its Refining, Technical & Research divisions at Baytown, Texas.

J. A. Dinwiddie has been promoted to research specialist in the Research & Development division. He will be engaged in research directed to the development of new or improved catalysts, fundamental studies of catalytic chemistry, and consultations on catalyst problems.

E. O. McBride has been promoted to technical specialist in the Technical Service division. His activities will be primarily in the fields of process designs for new installations and following their initial operations in the refinery.

F. H. Field has been promoted to senior research chemist in the Research & Development division. His duties include studies of hydrocarbon ion appearance potentials, use of instruments for calculation of bond strengths, and developing equipment to allow studies at reduced pressure of the gas phase reactions of carbonium ions, it was said in the announcement.

Indiana Standard to Offer New Reforming Process

A new refining process that gives greater yields of high-octane gasoline stocks will be made available to the industry by Standard Oil Company (Indiana), Joseph K. Roberts, general manager of research and development, said Standard's scientists developed the process over several years.

The process is a new way of improving the gasoline found in crude oil. This "straight-run naphtha" is low in octane number. To make it suitable for use in the gasoline required by today's cars, refiners must change it into an entirely different material which gives good anti-knock performance. The change is known as reforming.

In Standard's new reforming process, called Ultraforming, the change is brought about by a catalyst that contains platinum. A number of reactors are used, each holding a bed of catalyst pellets.

Ultraforming units now being built, and their daily capacities, are: at Pan-Am Southern Corporation's El Dorado, Ark., refinery, 6800 barrels; at Pan American Refining Corporation's Texas City, Texas, refinery 21,200 barrels; and at Standard's Wood River, Ill., refinery, 9000 barrels. Catalyst for the Ultraforming process will be supplied by American Cyanamid Company.

Quaker Board Chairman Dies at 86 at Oil City

Harry Jennings Crawford, director and chairman of the board of Quaker State Oil Refining Corp., died last month in Oil City Hospital, Oil City, Pa. He was 86.

Crawford, a pioneer in Venango County's oil industry, a financier, industrial leader and philanthropist, was honored last May at the International Petroleum Exposition in Tulsa, Okla., as "a pioneer of pioneers" in the oil and gas industry.

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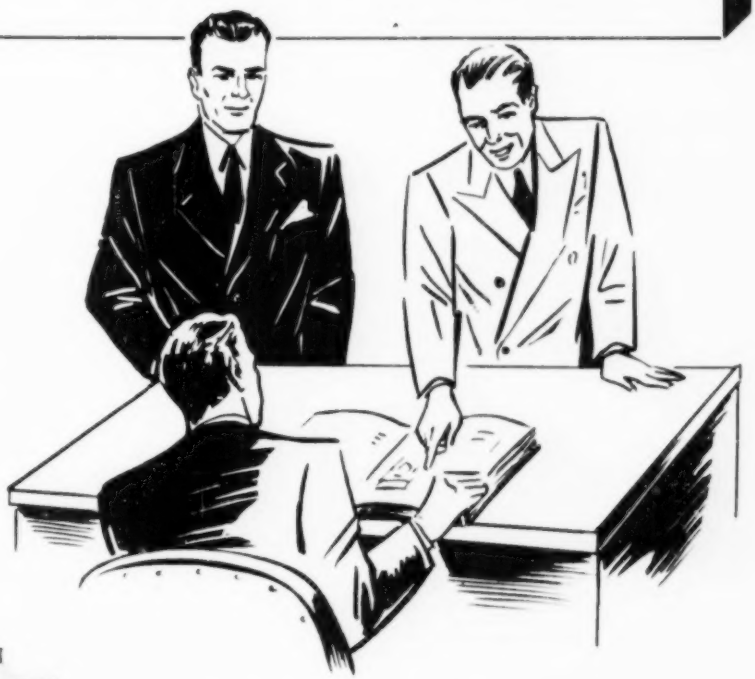

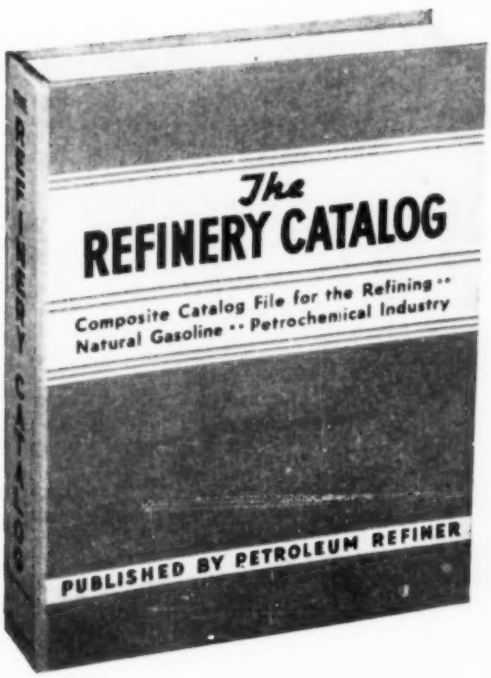
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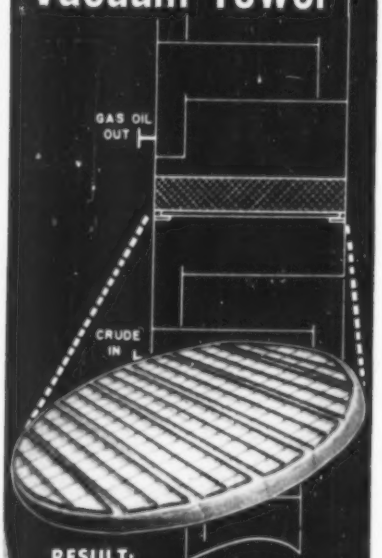

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Who's Meeting . . .

NGAA

At the Panhandle Plains regional meeting of the Natural Gasoline Association of America, W. H. Kehoe, American Meter Company, discussed the mechanical and human errors in gas measurement. Illustrated by slides, his approach was to point out such common mechanical errors as orifice wear, solids accumulation at the orifice plate, manometer and manifold piping leaks, and pulsation.

Natural Gas Pricing

M. F. Shaffer, Witco Chemical Company, traced the economic changes due to increasing value of natural gas.

By 1945 gas prices ranging from 4 to 6 cents per thousand cubic feet were commonly used in choice gas deals. Then its value became known to the promoters and investors resulting in a mad scramble for control of reserves. Additional inter-state transmission pipe lines were constructed to transport gas to the industrial northeastern U. S. Too, industries requiring natural gas, as a raw product or fuel invested millions of dollars in the construction of manufacturing plants in the gas producing states. Dwindling supplies of gas not already committed under long-term contracts resulted in keener competition, and by 1951 contract prices in some areas of Texas increased to levels ranging from 8 to 15 cents per thousand cubic feet, the higher prices being for substantial volumes of gas gathered and delivered to a central delivery point.

It would appear that it would be favorable for the natural gasoline plant operator to sell residue gas for a higher price. However, this is not always the case. For many years it has been the policy of the natural gasoline plant operator to charge the producer a certain amount for services such as compression, desulphurization and dehydration of the gas for delivery to pipe lines. Such policy is now questioned by producers due to the fact that gasoline plant operating pressures have been raised to levels substantially the same as that of the pipe line to enable the gasoline plant operator to obtain maximum hydrocarbon extraction efficiency. Since some gas is produced at high pressures, and very little compression is required for boosting the residue gas into pipe lines, the producer usually demands a higher percentage participation in the value of residue gas and liquid products sold. There is also a tendency on the part of the independent producers to do away with the complex participation type casinghead gas contracts, and receive a fixed unit price for their gas at the wellhead.

Gasoline plants of recent design have higher extraction efficiencies, which result in greater shrinkage and require more gas for fuel. With the increasing value of gas, shrinkage occasioned by hydrocarbon extraction and fuel consumed in operations now becomes a serious item of expense because gas so utilized could also have been sold at the increased prices.

Other Factors

The increasing value of gas is not the only economic factor presently challenging the natural gasoline industry. There are several other factors that are also becoming burdensome, such as increasing taxes, wages, costs of materials, and the low prices received for liquid hydrocarbon products. Development of new products or new uses for old products will probably be the key to survival of the natural gasoline plant. The rapidly expanding petrochemical industry appears to be the solution to at least some of the economic ills.

Other technical papers on the program included an operating paper by

RECEIVES AWARD—At the recent 28th Annual Fall Meeting of the CNGA, R. J. Hull (left), California Research Corporation, was presented the first annual award for meritorious service to the association. Presenting the award: L. V. Cassady, chairman of the award committee and past president of the association.

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Packaged Compressor Plant

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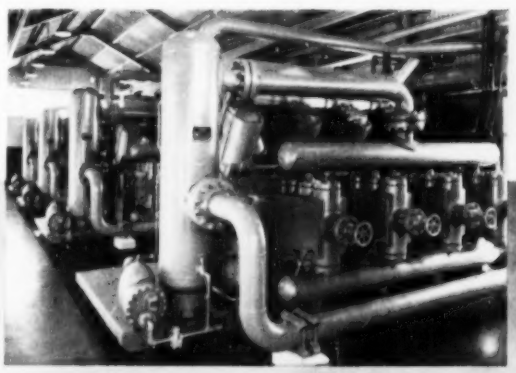
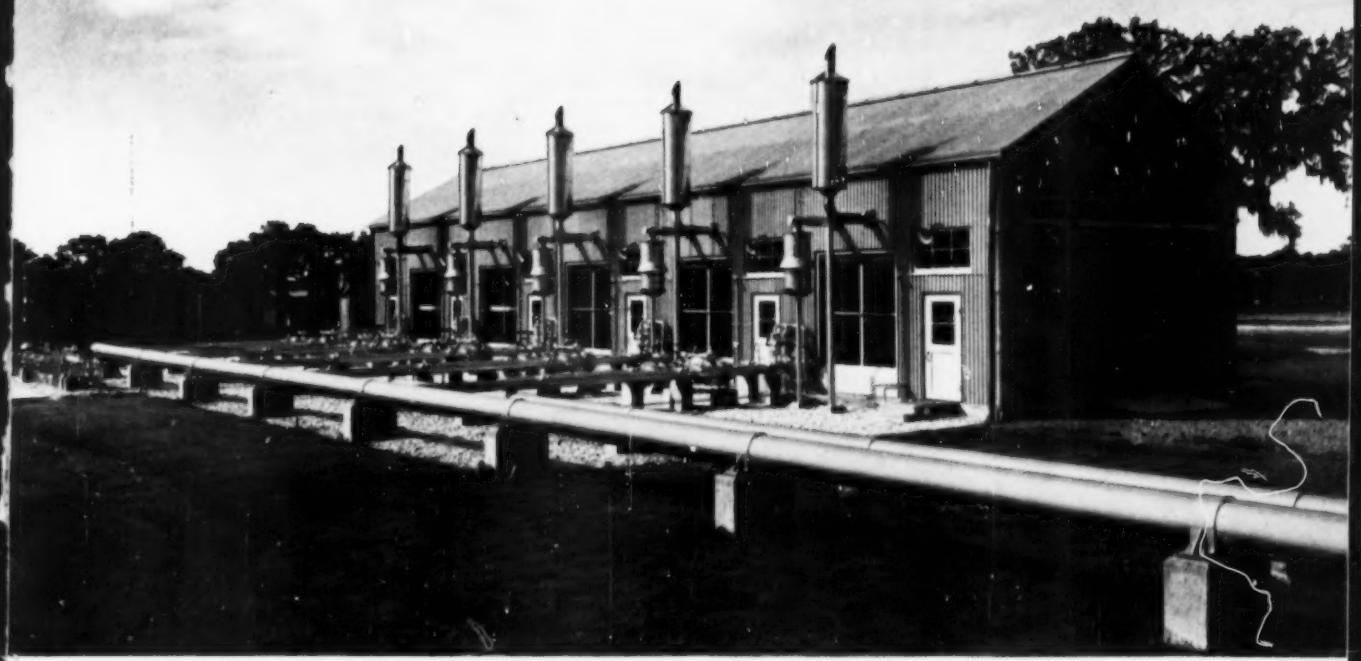
WILCOX TREND GATHERING SYSTEM, INC., picks up natural gas from fields along a 150 mile line and delivers it to the twenty-four inch main transmission line of Texas Eastern Transmission Corporation at that company's Provident City, Texas terminus. To maintain pressures required to move the gas into Texas Eastern's line, Wilcox installed a bank of five Beaird-Ingersoll-Rand packaged compressor plants. These plants, located near Thomaston, Texas were equipped with regulators which vary the speed of their 4-cycle engines from as low as 50 per cent to 100 per cent. The regulators automatically slow down the engines or speed them up to maintain the required discharge pressure at the compressors in spite of fluctuating volumes and suction pressures from the fields. The packaged plants were engineered, built and assembled in the Beaird factory and shipped to location as complete, self contained plants. *Let us give you all the facts about Beaird-Ingersoll-Rand packaged compressor plants.*

5 Packaged Compressors —

AUTOMATIC CONTROLS MAINTAIN STEADY DISCHARGE PRESSURES



Each of these five Beaird-Ingersoll-Rand packaged compressor plants includes Ingersoll-Rand gas engine driven compressor, Young radiator and all necessary components, connections and controls. Other sizes from 110 h.p. to 550 h.p.



THE J. B. BEAIRD COMPANY, INC.

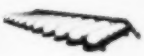
SHREVEPORT, LOUISIANA

BEAIRD

MACHINING MANUFACTURING STEEL WAREHOUSE

PACKAGED COMPRESSOR PLANTS

CAST STEEL FITTINGS



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BEAIRD

MACHINING MANUFACTURING STEEL WAREHOUSE

John Campbell, Black, Sivalls & Bryson, Inc., on "Dehydrating Light Hydrocarbon Liquids" and an over-all picture of "Our Resources and Petrochemicals" by R. W. Rasmussen, Celanese Corporation of America.

API

P. C. Spencer, president of Sinclair Oil Corporation, New York, is the new chairman of the board of directors of the American Petroleum Institute. He was elected last month at the Institute's 33rd Annual Meeting in Chicago to succeed L. S. Wescoat, president of The Pure Oil Company, Chicago.

Election of officers was the order of the day at the many different sessions at the four-day meeting.

Frank M. Porter, president of Fain-Porter Drilling Company, Oklahoma City, and president of the API, was reelected, and Charles S. Jones, president of Richfield Oil Corporation, Los Angeles, was elected API vice president for the Division of Transporation, succeeding Spencer.

New Vice Presidents

Vice presidents reelected for another one-year term were:

John G. Pew, vice president of Sun Oil Company, Philadelphia, for the Division of Production; John W. Newton, vice president of Magnolia Petroleum Company, Dallas, for the Division of Refining; and Robert M. Bartlett, vice president of Gulf Oil Corporation, Pittsburgh, for the Division of Marketing.

B. Brewster Jennings, president of Socony-Vacuum Oil Company, Inc., New York, was reelected treasurer, and Lacey Walker, New York, was reelected secretary and assistant treasurer.

Refiners' General Committee

The Division of Refining, meeting on the first day, elected the following to serve on its General Committee for 1954:

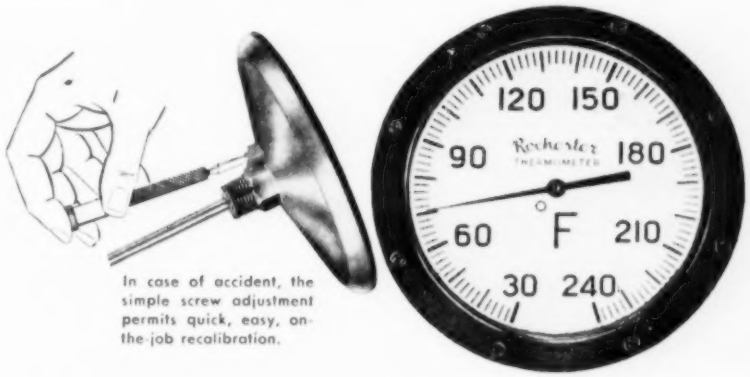
Gale S. Adams, General Petroleum Corporation; W. R. Argyle, Sinclair Refining Company; Fred B. Behrens, Wilshire Oil Company, Inc.; M. S. Berinser, British American Oil Company, Ltd.; Ralph Booker, National Cooperative Refinery Association; James T. B. Bowles, Crown Central Petroleum Corporation; Harry A. Brown, Frontier Refining Company; George H. Burruss, Anderson-Prichard Oil Company; W. J. Carthaus, Deep Rock Oil Corporation; H. S. Chase, Tide Water Associated Oil Company; G. A. Davidson, Standard Oil Company of California; C. E. Davis, Shell Oil Company; David E. Day, Richfield Oil Company; Roy J. Diwoky, Pan-Am Southern Corporation; George S. Dunham, Socony-Vacuum Oil Company, Inc.; E. E. Ebner, Quaker State Oil Refining Corporation; A. G. Farquharson, McColl-Frontenac Oil Company, Ltd.; H. W. Ferguson, Humble Oil and Refining Company; Max M. Fisher, Aurora Gasoline Company; M. Halpern, The Texas Company; T. A. Helling, The El Dorado Refining Company; H. Y. Hyde, Tide Water Associated Oil Company; K. E. Kingman, Union Oil Company of California; and J. A. LaFortune, Warren Petroleum Corporation.

Also, J. Porter Langfitt, The Pure Oil Company; Harry A. Logan, Jr., United Refining Company; R. E. Luton, The Ohio Oil Company; George L. Macpherson, Imperial Oil Limited; H. W. Manley, Sunray Oil Corporation; F. L. Martin, Suntide Refining Company; G. L. Mateer, Cities Service Research and Development Company; E. B. McConnell, The Standard Oil Company (Ohio); F. W. McCurry, The Derby Oil Company; L. W. Moore, Pan-American Refining Corporation; Donald M. Morrison, Shell Oil Company, Ltd.; William Naden, Esso Standard Oil Company; Glenn E. Nielson, Husky Oil Company; Harold G. Osborn, Continental Oil Company; H. M. Paulsen, Bankline Oil Company; John S. Pfarr, Leonard Refineries, Inc.; W. Harold Rea, Canadian Oil Company, Ltd.; L. W. Robbie, Republic Oil Refining Company; J. B. Rogerson, Lion Oil Company; J. L. Sewell, Taylor Oil and Gas Company; Henry Sonneborn III, L. Sonneborn Sons, Inc.; W. F. Stroud, The Atlantic Refining Company; C. L. Suhr, The Pennzoil Company; T. J. Sullivan, Gulf Oil Corporation; C. C. Tate, Phillips Petroleum Company; C. H. Thayer, Sun Oil Company; R. L. Tollett, Cosden Petroleum Company; J. W. Vaiden, Skelly Oil Company; and John S. Wertz, The Vickers Petroleum Company.

Who's Meeting . . .

New API Directors

Newly elected directors of the API for 1954 are: D. T. Staples, Tide Water Associated Oil Company, representing the



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Who's Meeting . . .

Pacific Coast production group; C. E. Spahr, The Standard Oil Company (Ohio), who succeeds O. F. Moore in the pipe line transportation group; Rodney S. Durkee, Lane-Wells Company, M. E. Montrose, Hughes Tool Company, and A. S. Knowles, Parkersburg Rig and Reel Company, who succeed M. B. Jones, F. F. Murray, and George O'Leary in the supply group; and T. M. Martin, Lion Oil Company, and Stanton K. Smith, Smith Oil and Refining Company, who succeed Jacob France and S. A. Amberson, Jr., in the at-large group nominated by the board of councillors.

Board Action

The board of directors elected for a two-year term three new directors: Harry W. Bass, H. W. Bass & Sons; Robert G. Dunlop, Sun Oil Company; and Charles Z. Hardwick, The Ohio Oil Company.

In other board action, J. E. Warren, of Midland, Texas, was elected to fill the unexpired term caused by the death of E. B. Reeser, and resignations were accepted from Robert H. Colley and William F. Humphrey, whose terms of office normally would not expire until the annual meetig in 1954. To fill these unexpired terms, the board elected, respectively, Dwight T. Colley, The Atlantic Refining Company, and Lloyd E. Bayer, Tide Water Associated Oil Company.

Chicago Entree

But the election of officers was only the appetizer for delegates to the meeting. The entree consisted of talks by top men in the industry and government on industry problems and developments. Among them were:

Secretary of Interior McKay, who is also Petroleum Administrator for Defense, who said he sees "no need, no excuse, for any government dictation" to the oil industry on the imports problem or any other problem. McKay emphasized that he didn't mean that he thought there is no present problem of over-production in the industry, or that he thought that there should never be a point to which imports might be reduced in order to prevent serious danger to the domestic industry. What he meant, he said, was that he sees "no need, no excuse, for any government dictation to the industry on this pressing problem—or any other."

H. S. M. Burns, president of Shell Oil Company, who branded as "fairy tales" charges that the oil business is a monopoly. His proof that the charges are false was the fact that so many brands of petroleum products are available in the U. S. and that there are so many rival claims for superiority.

E. G. Ellerbrake and F. Veatch, The Standard Oil Company (Ohio), who told of the development of a new foam-like substance called "Microballons" to cut evaporation losses of crude oil. They reported that field tests show that the new method reduces evaporation losses of crude oil from cone-shaped storage tanks more than 80 percent under a variety of conditions.

Frank M. Porter, president of the API, who expressed confidence that the oil industry will solve its problems. He said that the serious and rational consideration given to problems in the past by the API should be the answer to today's problems.

SAE

At the Society of Automotive Engineers National Fuels and Lubricants Meeting, James M. Mason and H. E. Hesselberg, Ethyl Corporation, discussed "Engine Knock as Influenced by Precombustion Reactions."

The Knock Problem

The study was undertaken in order to learn more about how these precombustion reactions influence knock, which in turn limits the power and efficiency of an automobile engine. When gasoline burns in an engine, the entire combustion cycle of the fuel-air mixture occurs in as little as 1/25 of a second. Up to now, the problem has been to isolate these precombustion reactions, for study purposes, from the rest of the combustion process. This problem has now been solved with the newly developed Ethyl research technique.

In this approach, Mason reported, one test engine, operated at normal speed by an electric motor, compresses the fuel-air charge but does not ignite it. The reaction products from the first engine are then piped into a second identical engine where they are used as fuel and ignited in the usual manner by a spark plug.

By so doing, the author explained, it has been possible to measure in the second engine the knocking tendency of the precombustion reaction products created in the first engine. This method

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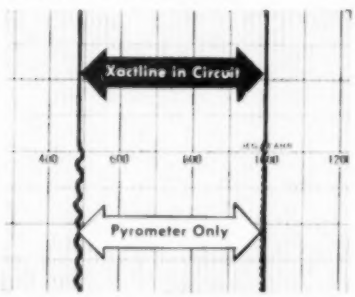

Exact reproduction of temperature chart for a heating process showing the comparison of the "Straight-Line" temperature control produced by XACTLINE and the saw-tooth curve obtained with only conventional control.

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115 or 230 Volts, 60 Cycle.
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Who's Meeting . . .

provided information on the progress of knock-inducing reactions caused by various degrees of compression of the fuel-air charge in the first engine.

Discussing the research findings, the author pointed out that when a normally-operated engine is run on a fuel-air mixture that is previously compressed but not fired, the change in antiknock quality of the mixture is an extremely sensitive indication of the precombustion reactions preceding normal combustion. Of particular importance in this respect, he added, is the fact that reactions occurring in the fuel-air mixture with no detectable energy release have been shown to produce materials which markedly increase knock. Precombustion products from reactions which result in appreciable energy release, however, are not strongly knock inducing. The addition of tetraethyl lead, he said, does not influence the start of either of these precombustion reactions, but does act to retard the onset of auto-ignition.

AIChE

A record 2000 or more persons are expected at the 46th Annual Meeting of the American Institute of Chemical Engineers to be held in St. Louis, Missouri, December 13-16, 1953, at the Hotel Jefferson. Arrangements for the meeting include technical symposia, a student program, trips to industrial plants, the transaction of Institute business and the presentation of professional honor awards.

There will be three sessions of general papers on chemical engineering, covering such topics as performance of packed towers and of bubble cap trays, ion exchange, a semi-commercial plant for resins, and numerous other topics.

Symposia on problems of current interest will cover the following subjects:

Productivity in chemical manufacturing—the measurement of productivity and the use of this concept in the chemical industry.

Processing of coal and oil shale—carbonization methods for coal and lignite, gasification of coal dust, and retorting of oil shale.

Distillation—including factors influencing plate efficiency, batch rectification and mass transfer in distillation.

Industrial waste treatment—use of ion exchange in waste treatment, waste treatment for the metal finishing industry, aquatic biology, and catalytic oxidation of aqueous wastes.

Heat transfer—including heat transfer in boiling liquids, in liquid metals, in fluidized beds, convective heat transfer, and heat transfer properties of liquid-solid suspensions.

Dust and mist collection—the properties of dusts, mists and smokes, and the performance of various types of collectors.

Fundamentals of digital computors—the functions of digital computors and the preparation of problems for these devices.

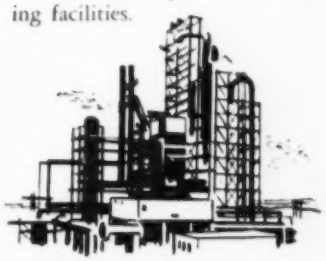
Drying—theoretical aspects of the drying operation and the performance of various types of drying equipment.

MCA

Representatives of the Manufacturing Chemists Association and the Southern

Problem

To produce more ammonia without excessive expansion of existing facilities.



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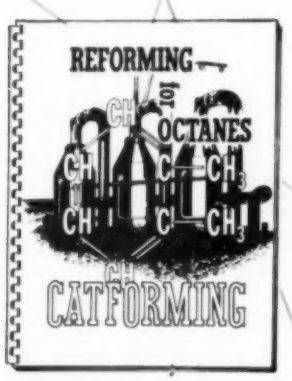

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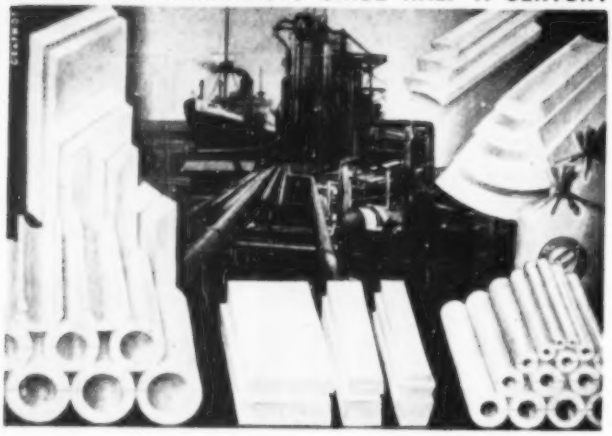

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Who's Meeting . . .

Association of Science and Industry, Inc., met recently at Atlanta, Ga., to complete arrangements for the 1954 Southern Industrial Wastes Conference. The conference is to be held in cooperation with the Texas Chemical Council at the Shamrock Hotel, Houston, April 21-23, 1954.

The program at the 1954 meeting will cover both air and stream pollution problems, including managerial as well as technical aspects. The Houston conference will be the largest assemblage ever held in this country of experts in the field of pollution inquiry and control. Attending will be representatives of academic research, industry, government, state and civic agencies.

IN THE FUTURE

DEC.	
15-16	American Institute of Chemical Engineers (Annual Meeting), Jefferson Hotel, St. Louis.
JAN. 1954	
11-15	Society of Automotive Engineers (Annual Meeting and Engineering Display) Sheraton-Cadillac and Statler Hotels, Chicago.
18-22	American Institute of Electrical Engineers (Winter General Meeting), Statler Hotel, New York.
25-28	Plant Maintenance and Engineering Conference, Conrad Hilton Hotel, Chicago.
FEB.	
11-12	Western Petroleum Refiners Association (Regional Meeting), Hotel Beaumont, Beaumont, Texas.
15-17	American Petroleum Institute (Lubrication Committee), Sheraton-Cadillac Hotel, Detroit.
23-24	Packaging Institute (Petroleum Packaging Committee), Houston.
26	Natural Gasoline Association of America (Permian Basin Regional Meeting), Lincoln Hotel, Odessa, Texas.
MAR.	
1- 5	American Society for Testing Materials (Spring Meeting), Shoreham Hotel, Washington, D.C.
8-10	American Institute of Chemical Engineer, Statler Hotel, Washington, D.C.
15-19	National Association of Corrosion Engineers (Tenth Annual Conference), Municipal Auditorium, Kansas City, Mo.
25	National Industrial Conference Board, Ambassador Hotel, Los Angeles.
29-31	Western Petroleum Refiners Association (Annual Meeting), Plaza Hotel, San Antonio, Texas.
APRIL	
5- 7	American Society of Lubrication Engineers, Netherland-Plaza Hotel, Cincinnati.
14-16	National Petroleum Association 51st Semi-Annual Meeting), Cleveland Hotel, Cleveland.
21-23	Natural Gasoline Association of American (33rd Annual Convention), Baker Hotel, Dallas.
MAY	
3- 5	American Petroleum Institute (Lubrication Committee), Skytop Lodge, Skytop, Pa.
3- 7	American Petroleum Institute (Safety & Fire Protection Committees, Midyear Meeting), Chase-Park Plaza, St. Louis.
9-12	Liquefied Petroleum Gas Association (Annual Convention), Conrad Hilton Hotel, Chicago.
10-13	American Petroleum Institute (Division of Refining, Midyear Meeting), Rice Hotel, Houston.
16-19	American Institute of Chemical Engineers, Springfield, Mass.
17-21	National Fire Protection Association, (58th Annual Meeting), Statler Hotel, Washington, D.C.
20-21	National Industrial Conference Board (38th Annual Meeting), Waldorf-Astoria, New York.

Medical Research Promotes Safety

Industry's efforts to guard against possible harmful effects of new products brings into safety field a unique team of specialists

Robert E. Spann, Refiner Staff,
New York

THE PETROLEUM industry's steadily improving safety record each year is the result of a cordinated effort to reduce exposures that could cause injuries to personnel. Considering the immense volume, measured in millions of barrels daily, and the inherent characteristics of the material handled, the results have been remarkable.

While the average employe may associate safety and accident prevention only with the programs conducted by safety engineers, the industry's safety record has been achieved through a comprehensive approach by a wide variety of specialists.

Starts with Metallurgists

It starts with metallurgists who must select metals to be used in the plants that will stand greater stresses than could be expeced during normal operations; the designers who must then design equipment and plants with safety of operating and maintenance personnel as a foremost consideration; and, after installation, operation and maintenance of equipment and plant must be in accordance with the designer's specifications.

Preparing for safe operations involves more than having properly designed equipment incorporating the best safety devices. It also includes the materials to be handled. The science of petroleum refining grows ever more complicated. New materials are being handled, new processes are developed, and at the end of the refinery stream new products are coming out to fill military, industrial and public demands.

Just as the modern refinery is little akin to the first crude stills, the complex products now being made have little in common with the lamp oil of a century ago. With the advance in the complexities of the chemicals and products used in, and produced by, refineries a new science of safety has been created. It's the preventive role of medical research.

Medical research is directed toward finding new materials, products and processes under consideration for use in the refining operations could produce harmful physiological effects, learning of the nature of these effects, and how to eliminate them. This research effort has brought a new team of specialists into the field of safety. The members of the team are *medical* doctors, industrial hygiene engineers, biologists, chemists and toxicologists. Unique research in this direction in the refining industry is being conducted by the Medical Research Division of Standard Oil Development Company, the central research affiliate of Standard Oil Company (New Jersey). The work of the division has resulted in many recommendations ranging from protective safeguards for individuals to actual changes in design of plant and equipment as well as product composition.

Early Work in Labs

As the name indicates, the work of these specialists starts in the laboratories—not medical laboratories but petroleum research laboratories where new products and processes are under consideration. Medical researchers work with research chemists and engineers, conducting tests step-by-step in the development stage to determine if the new materials or products contain compounds that could have harmful physiological effects on employes or consumers.

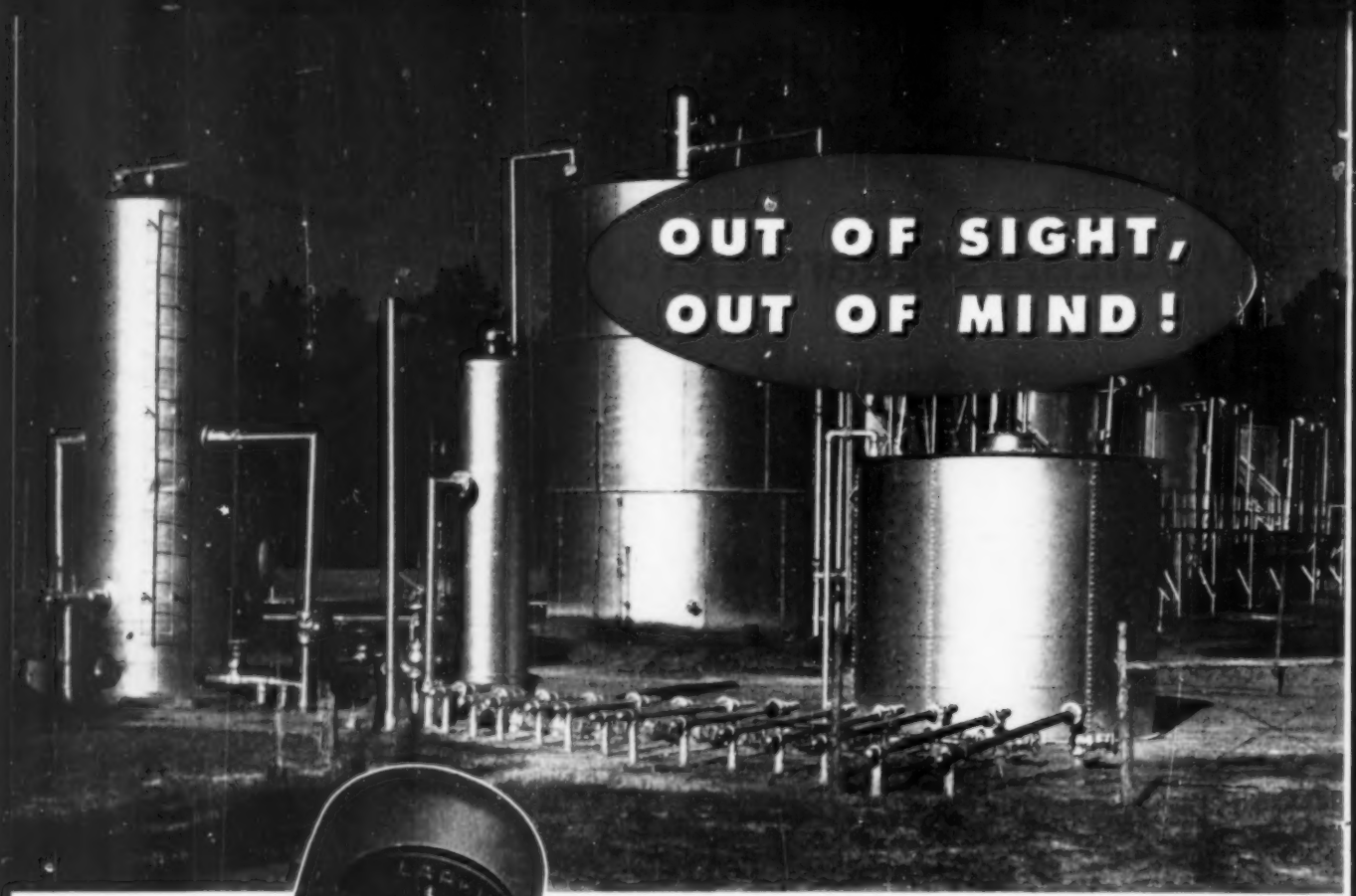
Once a product or process has been approved in the laboratory, the medical researchers follow it through the pilot plant stage, where production runs can be made and full evaluation can be given to potentially hazardous exposures that could be experienced by personnel. Particularly, the medical researchers give thorough examinations to compounds that may be potentially carcinogenic or toxicogenic. Frequently, many changes in the types of equipment, valves, fittings and mechanical safeguards have to be made before the medical researchers will approve the new product, material or process for commercial application. Research may have to be re-directed if the new process or product is indicated to pose problems of chronic physiological nature.

Safety Practices Checked

Once commercial-scale operations commence, the industrial hygiene engineers work with plant safety engineers to keep a close check to insure that all recommended safety practices are being followed in the plant. The findings that have been made from this careful approach to date convince the medical researchers that no material is too dangerous to handle from a physiological aspect provided it is handled properly. Thus, the biggest part of the medical researchers job is to find out how to handle safely all potentially hazardous materials and to enforce their recommendations in the plants.

Although many phases of medical research had been conducted by the various affiliates, the first coordinated effort was in 1945 when Jersey Staadard established a special division of its Medical department to study the problems of toxicity in petroleum processes and products. This assignment was given to Dr. J. P. Holt, who recommended that the research be first directed at the plants to determine the possible hazards, if any, during production.

N. V. Hendricks, an industrial hygiene engineer who now heads the industrial hygiene section of the Medical Research Division, was assigned to



• In installations like these, often more swage nipples and bull plugs are used underground than above. When Larkin fittings are specified, they can be buried and forgotten because they are well protected against corrosion and have a generous safety factor. Thousands have given satisfactory service for years in underground hook ups.

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survey all refineries of Jersey Standard's affiliates to determine if there were exposures to potentially toxic materials. Dr. R. E. Eckardt was brought into the division to correlate the clinical phases of toxicity with industrial hygiene and he now heads the Medical Research Division. After its formation the division was transferred to Standard Oil Development to be at the scene of new product and process development.

M.D.'s and Ph.D.'s

The work of the division is handled by 17 persons, 10 of whom are technically-trained—two M.D.-Ph.D.'s, 5 industrial hygiene engineers, and 3 medical librarians. The division works closely with Jersey-Affiliated companies and several of the latter have industrial hygiene engineers in their refineries.

In addition to the close checks on new materials, products and processes after they go into commercial-scale operations, industrial hygiene engineers in the refineries conduct continuing surveys on potentially hazardous exposures, making sure that flow systems remain "closed," that proper ventilation is provided, and that employes, where necessary, wear proper protective clothing. For the benefit of refinery employes in tropical climates, where rubber or plastic protective clothing is uncomfortable, the medical researchers have studies under way to find a type of clothing that will afford the maximum protection and still be comfortable to wear.

Frequently, to find the answers to the many problems of possibly hazardous materials the division has commissioned various universities and research groups to study and analyze any doubtful materials or compounds that may enter the processing stream. These findings then are applied to the possible uses of the material in a new product to learn if dangerous exposures will result.

Continuing Teamwork

The entire effort is part of the continuing teamwork that is paying dividends in improved performance. Many times the researchers' doubts about the safety of a new material or possible produce prove unfounded. But the employes and users of petroleum products have assurance that everything possible is being done to prevent hazardous exposures, and Standard Oil Development feels that this is an important consideration regardless of the research effort that may be required.

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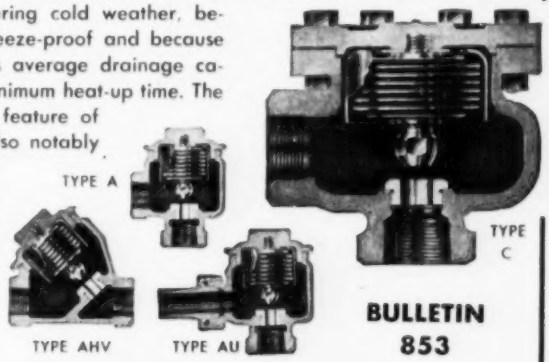

BULLETIN 853

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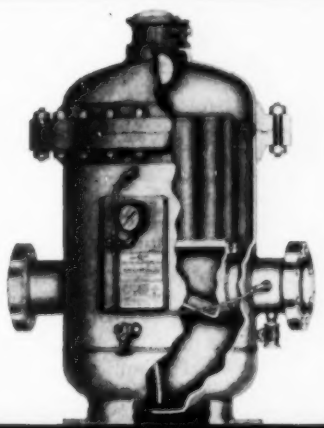

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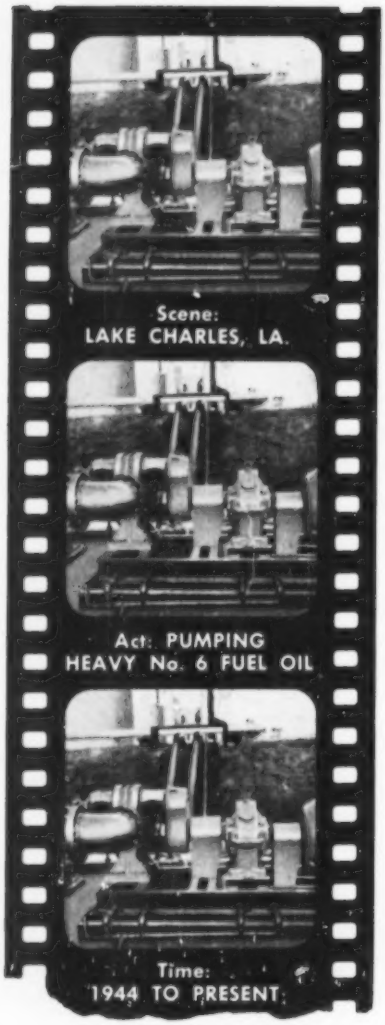

This pump—a Kinney Heliquad Model HQA 147-31A—has already seen nearly a decade of service at the Lake Charles, La. plant of Cities Service Refining Corp. The Kinney Heliquad is a slow speed, high efficiency rotary pump of unique design, employing steep helical rotors which are ideal for handling heavy oils and other viscous and non-viscous materials. Find out how this super-dependable pump can help in your plant. Send coupon for details. Kinney Manufacturing Co.—manufacturers of liquid and vacuum pumps. Representatives throughout the United States and in foreign countries.

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As Management Sees It . . .

The Courts Say . . .

in recent insurance cases

Shelton

This column is to inform—not advise. It presents the current trend in legal thinking on insurance cases. The law varies from state to state and its application depends upon the facts of the particular case. Do not attempt to apply it without consulting your attorney.

JOSEPH M. SHELTON, Attorney at Law, Dallas

That Traumatic Neurosis is compensable

EMPLOYE sustained injury to his foot and elbow due to an industrial accident and was totally disabled for four weeks. A pyschiatrist testified that there would be continued disability for six months due to neurosis. Trial court awarded judgment for employe. Insurance carrier appealed and the Court of Civil Appeals reversed the trial court on appeal by the employe.

The Texas Supreme Court said the Workmen's Compensation law provides that an injury is "damage or harm to the physical structure of the body and such diseases or infection as naturally result therefrom" (Art. 8309, Sec. 1, T.R.C.S.). Neurosis of the character suffered by the employe is a disease. He can not use his physical powers. He is incapacitated to do labor. The incapacity is not simulated; it is very real. The evidence warranted the trial court's finding that the neurosis resulted from the physical injury.

Hood v. Texas Indemnity Ins. Co.
209 SW 2d 345 (Tex. Sup. Ct., 1948)

That employer is presumed to know "injury" includes aggravation.

EMPLOYE CLAIMED that by reason of a fall, left leg was injured to the extent of total disability. Evidence disclosed pre-existing disability to the knee. Employe offered evidence that the accident aggravated the pre-existing condition. Employer said that can't be considered because "we had no notice of such a claim." Your claim was that accidental injury caused the disability—not aggravation." The trial judge excluded evidence of aggravation and the employe appealed.

The appellate court said if a blow to the leg injures that leg by aggravating a pre-existing disease, it is no less an injury from the blow within the meaning of the compensation act. Since the employer is presumed to know that rule of law, it is logical that a claim for injury to the leg by accident is sufficient to notify the employer that an aggravation may be claimed.

Ledford v. Miller Bros. Co.
253 SW 2d 552 (Tenn. Sup. Ct., 1952)

That an injury may itself be an accident

EMPLOYE WAS A TRUCK DRIVER and while unloading a truck load of equipment on a freight platform suffered a heart attack and died before reaching a hospital. Widow claimed compensation. Employer defended on the ground that there was no "injury by accident" as required in the compensation act.

The Tennessee court said "injury by accident" is not confined to injury caused by "violent, external, accidental" means. An internal injury that is itself sudden, unusual, and unexpected is none the less accidental because its external cause is a part of the victim's ordinary work. The award of compensation to the widow is affirmed.

—Patterson Transfer Co. et al. v. Lewis
260 SW 2d 182 (Tenn. Sup. Ct., 1953)

Says YES—
Heavy Imports Threaten Industry

(Continued from Page 76)

ing that imports will be reduced to a supplementary role, and maintained in an equitable relationship to domestic demand, the future of the domestic oil industry will be one of growing and discouraging uncertainty.

World Overabundance. There is a world overabundance of crude petroleum. The Middle East alone has an exportable surplus substantially in excess of 2 million barrels daily. Revival of production in Iran could aggravate the already serious impact on the domestic industry, growing out of the world surplus of oil.

It should be made clear that the domestic oil industry has never advocated that oil imports be "cut off," nor has it maintained that all imports are injurious.

There is no quarrel with the ownership of foreign oil by American nationals. Foreign oil in its proper role is useful in supplementing U. S. production. It is important to the economies of the countries in which it is produced.

Although the value of development of oil resources throughout the free world cannot be questioned, the importance of these foreign reserves to the U. S. must not be emphasized to the detriment of our own industry. We cannot afford to become dependent upon foreign nations for our oil requirements in peace or war.

We must be realistic about what we can depend on, in the way of oil supplies, for our security. Our first line of defense lies in that oil available on the North American continent, in the U. S. and Canada. Of secondary importance, in war, would be the reserves of South and Central America. Middle East oil which has made serious inroads into the U. S. market since 1946, would be unreliable in war.

Thus, the only oil the U. S. can absolutely depend on in time of emergency will be that in the U. S. and Canada and such South American oil as our Navy and Air Force can protect and make available to us.

Just as it would be unthinkable to erect our aircraft, shipbuilding and munitions plants in the Middle East and other scattered points on the globe, it would be equally ridiculous to allow ourselves to become dependent on oil from such remote areas. Without a defensible supply of oil, our planes, tanks and guns would be of little use against any enemy.

Increasing dependence on foreign oil threatens the entire domestic industry—not just the producing branch. For example, the great bulk of U. S. refining capacity has been built, and is based, upon the continuance and growth in availability of domestic crudes.

Of 320 U. S. refineries as of last January 1, all but 30 were in inland states. These inland refineries, built near domestic crude sources, are the backbone of our vast petroleum processing system. In recent years, they have greatly expanded production of such essential products as petrochemicals, jet and aviation fuels, explosives, and synthetic rubber compounds.

In any future war, it would be strategically important—and fortunate—that the great preponderance of our oil production and processing facilities are in sections least vulnerable to attack. Keeping these facilities at full strength is of paramount importance. It cannot be done when foreign oil is imported to the point of weakening the domestic industry.

Expansion Curtailed. The problem confronting the domestic industry, in face of continued excessive imports, is its inability to accomplish necessary expansion.

At the beginning of World War II, we had a reserve shut-in oil producing capacity of 1 million barrels daily. At that time we were a net exporter of oil. Our excess capacity was a true reserve, for it was over and above total U. S. consumption. Without imports, we could have supplied demand and, in addition, produced 1 million barrels a day.

The domestic industry is today carrying an idle capacity estimated at roughly 1 million barrels a day, but this is in no way a real reserve capacity. If our imports were suddenly cut off, we would not have a single barrel of excess productive capacity.

The oil industry must carry a proper reserve capacity because of security requirements. This productive capacity is developed and maintained by the industry with funds obtained through sale of crude oil and its products. If the domestic industry is to generate the capital necessary to provide the reserve capacity required for our security, it must have an adequate price and sufficient market outlet. This will require that imports be maintained in balanced relationship to demand.

We will never have a true reserve capacity unless we develop the capacity to produce more oil, within the U. S., than is needed during emergency. And we cannot create a real reserve capacity by increasing imports and shutting in domestic production.

As a nation we face the choice of two alternatives: either place imports on an equitable basis with the U. S. production and thus encourage full development of our reserves, or invite unlimited importation of foreign oil and place reliance on remote and indefensible supplies.

Strong arguments are put forth in support of increased imports. Some even resort to the false claim that we are a "have-not" nation as to petroleum, and that we are "running out of oil." Others argue that we should import foreign oil to "conserve" our own. History, however, has proved the fallacy of such arguments.

The belief that our oil resources can be conserved for future emergencies is neither logical nor sensible. In 1920 our proved reserves of petroleum liquids totaled 7 billion barrels. Had we then shut in that reserve for future emergency, and relied on foreign oil, we would have been totally unable to fuel World War II.

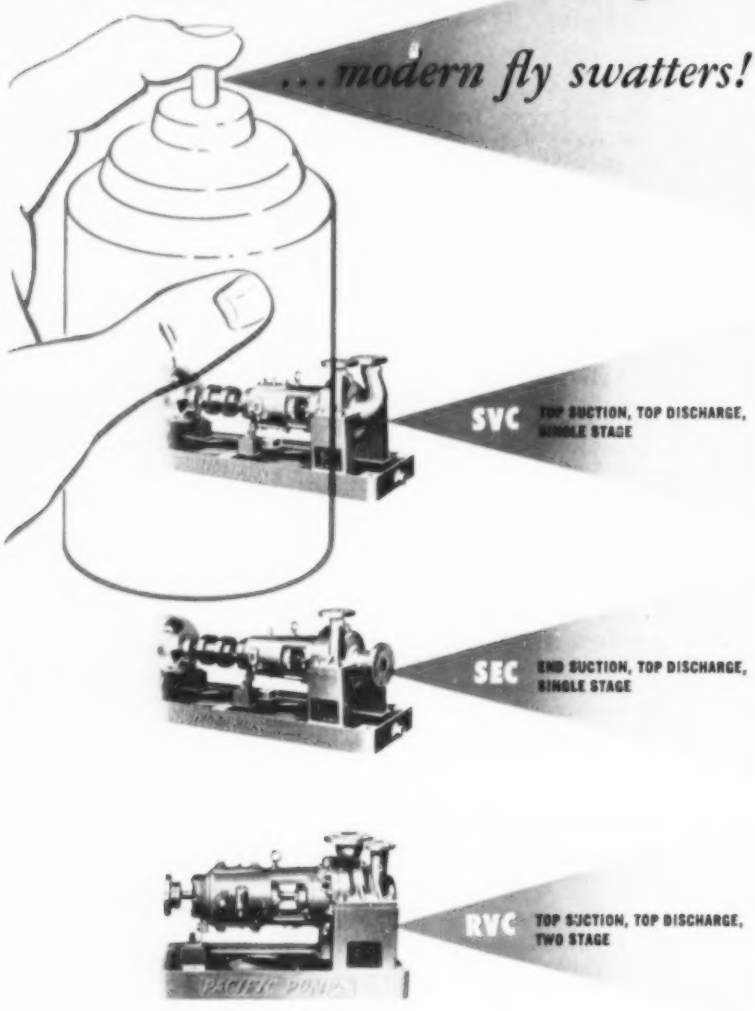
Not Enough for War. Although our reserves today are near 33 billion barrels, despite the fact that we have used 41 billion barrels since 1920, our productive capacity undoubtedly would prove inadequate should World War III begin tomorrow. While we have time on our side, We must do all possible to encourage full development of our liquid fuel resources. To do less is to invite disaster.

The domestic industry desires to prevent imports from taking a disproportionate share of the domestic market, disrupting the domestic industry, upsetting the conservation programs of the states and preventing the maintenance of an oil productive capacity commensurate with our defense requirements.

It is to be hoped that some method will be forthcoming from the industry itself to restrict imports in a realistic and flexible manner. Unless such a solution is reached, then legislation will be required in the national interest.

If it is desirable to prevent the waste of domestic oil, and to build up an adequate reserve producing capacity, the domestic industry must know—is entitled to know—that a sound policy as to imports will be assured.

Pacific Process Pumps



★ Custom fabricated from properly chosen materials to perform their tough jobs, Pacific process pumps give a mighty assist in the production of insect sprays, detergents, antiseptics and a host of other products that safeguard health and give comfort to mankind . . . thus in a sense becoming "modern fly swatters." The widespread use of Pacific process pumps for heavy-duty assignments in the petro-chemical industry is conclusive proof of Pacific's ability to perform continuous service with sustained economy.

Pacific single-stage Types SVC and SEC handle liquids from sub-zero to 800°F., 15 to 1,600 gpm, 500 to 600 psig, discharge pressure, differential heads up to 600 feet, speeds to 4,000 rpm. Two-stage Type RVC pumps liquids from sub-zero to 850°F., 50 to 600 gpm, discharge pressure to 600 psig, differential heads to 825 feet, speeds to 3,600 rpm. For further details, write for Bulletins 101 and 108.

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As Management Sees It . . .

Says NO— Import Flow OK'd

(Continued from Page 77)

chief categories of oil imports: crude oil and residual oils. Residual oil imports have no important effect on the domestic producer. Refiners are constantly striving to reduce their yield of this unprofitable end product; consequently refiners would not run any important additional amount of domestic crude just to make up a shortage of residual oil caused by import restrictions.

Crude oil imports can be brought into proper perspective by reference to the increase in total U.S. crude demand of 1,900,000 barrels daily since the first quarter of 1950. Imports supplied only 200,000 barrels a day of this increase.

Crude imports in the first nine months of 1953 averaged 653,000 barrels a day. This represented about 9.3 percent of the total U.S. runs to stills for the nine-month period, averaging 7,020,000 barrels daily. During 1949-52, imports of crude averaged about 8 percent of U. S. refinery runs.

Domestic producers during the period through September, despite cutbacks, produced an average of 6,535,000 barrels daily of crude, an increase of 363,000 barrels over the first nine months of 1952. In addition, domestic production of natural gas liquids averaged 655,000 barrels a day for the period, or just a little more than the volume of crude imported.

Needed Supplies. Further, import figures cited above include crude imported into California. These imports, which averaged about 83,000 barrels daily in the first three quarters of the year, were urgently needed to supply refiners on the West Coast with light gravity crudes that were not available otherwise. Recently, the largest importer on the West Coast announced that with a return to more normal working inventory levels it was reducing its crude imports.

U. S. producers have experienced cutbacks this year, particularly in Texas. Compared with the record volume of domestic crude oil production of December, 1952, averaging 6,634,000 barrels a day, domestic output in October was about 400,000 barrels a day lower. Some producers have blamed imports for the total amount of the cutbacks. The principal reasons for the cutbacks, however, are:

• The rapid increase in crude oil production during the last quarter of

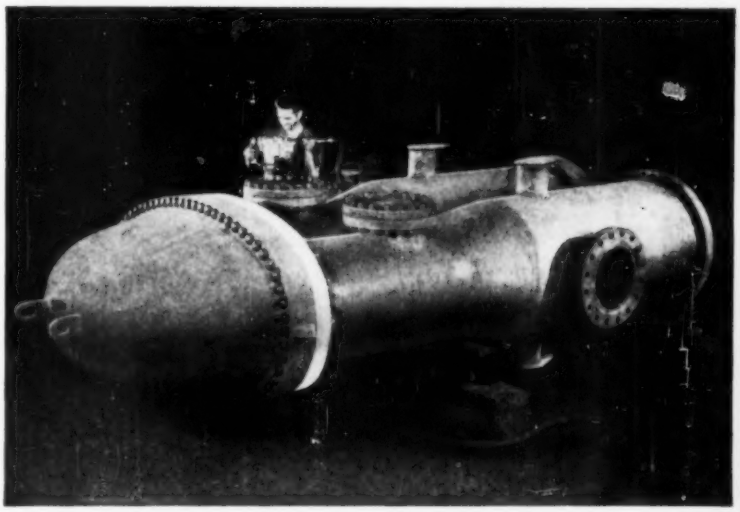
PROCESS EQUIPMENT NEWS

PUBLISHED BY FABRICATED PRODUCTS DIVISION, THE M. W. KELLOGG COMPANY DECEMBER, 1953

Unique Bundle Puller Makes Gains Abroad

Kellogg's Hydro-Ejector, a special device for hydraulically removing and retracting tube bundles, is now standard equipment in many refineries. The use in the United States has generated considerable interest abroad, and independents as well as U. S. affiliates are using this portable unit to speed maintenance work.

Experience has proved that two men can handle even the largest bundles, taking less than 25 minutes to perform the operation of ejecting or retracting any size unit a distance of eight feet. The Hydro-Ejector can exert a force of 12,000 pounds, sufficient to overcome dirt formations that cause many bundles to stick.



Special High-Temperature Exchangers for Gasoline-from-Coal Synthesis

Illustrated is one of ten unique heat exchangers especially designed and fabricated by Kellogg for use in a gasoline-from-coal synthesis plant under construction in South Africa. This exchanger is being made ready for hydrostatic testing.

When in service the units will perform a highly critical function in the pre-heating of gas in a catalytic reforming unit. Each capable of operating under temperatures of 1625°F and pressures of 365 psi, the exchangers are being fabricated in Kellogg's shops rather than overseas because of Kellogg's extensive engineering and fabrication experience in production of alloy equipment for handling critically high temperatures and pressures.

Tubes and tube sheets of the exchangers are fabricated of Type 310 stainless steel. The shells are internally insulated.

In the reforming unit, residual hydrocarbons in synthesis gas, produced in the coal gasification plant, and recycle gas from the synthesis section are converted to additional synthesis gas.

High-Pressure Units Scheduled for Chemical Plant

Four special high-pressure exchangers for a major chemical processor are now being designed in Kellogg's heat transfer division.

They are of the integral tube sheet-channel type because of the operating pressures which will be in the neighborhood of 1000 psi on the tube side. Each will contain a U-tube bundle consisting of 32-foot long copper tubes.

For further information, details of methods, etc. contact

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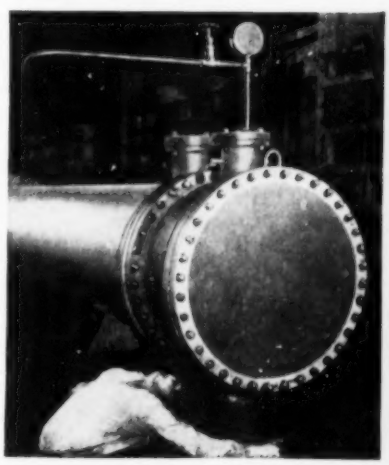
KELLOGG PULLMAN

Reflux Exchanger for Combination Unit

This reflux-crude exchanger is one of many exchangers, coolers and condensers recently completed in the shops for a combination refinery in Brazil. Here it is shown undergoing hydrostatic testing.

The unit is 35" inside diameter, of steel construction throughout, using $\frac{3}{4}$"OD tubes on square spacing. When installed the unit will preheat crude against reflux gas oil raising its temperature from 60° to 280°F.



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1952, which amounted to 271,000 barrels daily over the third quarter of that year. This high rate was continued into the first quarter of 1953. After a short cutback period in April and May, the rate of production returned to a high level until September when new cutbacks were started.

- The exceptionally warm weather during the 1952-53 winter, which reduced consumption of liquid fuels by an estimated 236,000 barrels daily.

- Increasing competition from natural gas—the additional gas consumed over the last heating season was equivalent to about 300,000 barrels daily of fuel oil.

Imports also are blamed for having reduced the incentive to drill for oil in this country. On the contrary, drilling continues upward. In 1952 more wildcat and development wells were drilled, a greater total footage was drilled, and more geophysical crews were employed than in any previous year. Results for the first half of 1953 show that a new high in drilling was reached for a January-June period and present indications are that a record drilling year will be established for all of 1953.

Petroleum demand so far in 1953 has been about 6 percent higher than in 1952. A further expansion in requirements is predicted for 1954 by leading petroleum economists. This would strongly indicate, that after proper adjustments in inventories are made, higher domestic production will be required to fill demand.

Looking further into the future, there are additional indications in the report of the President's Materials Policy (Paley) Commission that the present situation in the oil industry is only temporary. Figures in this report indicate that without the help of additional imports the domestic industry would have to find an average of 4.8 billion barrels of additional oil annually for the next two decades in order to meet estimated demand and to keep our reserves in proper relationship. That means the average would have to be 50 percent greater than the industry was able to find in 1952 (including revisions of previous findings).

If War Comes. If war should come in spite of all of our efforts for peace, supplies in South America, the Middle East and Far East will acquire special importance because of the type of war we may be fighting or because of their availability nearer the point of military need. This is of prime logistical importance since oil products represented 60 percent of our total tonnage shipped in World War II. If we should

As Management Sees It . . .

lose any of our foreign oil concessions through ill-advised actions on our part, it would reduce the free world's present 11-to-1 superiority in oil production over Russia and her satellites—a major deterrent to any large-scale Soviet aggression.

Aside from the importance of petroleum imports to our own economy in peace and in periods of emergency, the oil which is imported into the U. S. represents an important source of dollar income to the exporting nations. For example, oil accounts for about 70 percent of the Venezuelan government's revenue and over 95 percent of its foreign exchange. Without these dollars Venezuela would be unable to keep up her purchases of over $1½ billion annually of American goods. The U. S. is by far the largest exporter to Venezuela and that country is one of our best customers. In addition to Venezuela, Canada, Colombia, Mexico and countries of the Middle East supply us with oil and buy American goods.

Just as the anticipated rate of growth in U. S. petroleum consumption dictates that we cannot depend solely on domestic sources, neither can we rely upon a single foreign source to supplement our supply. Foreign sources of supply in the Western Hemisphere are, of course, less apt to be denied us in the event of another war. The findings contained in the Paley Commission report, however, make it dramatically clear that we cannot afford to indulge in hemisphere isolationism in so far as oil is concerned. According to that report, the U. S. will have to import 1.2 million barrels a day from the Middle East by 1975. This assumes that we will already be importing the maximum surplus, amounting to 1.3 million barrels a day, available to us from all Western Hemisphere sources.

Our own current and future need for Middle East oil is relatively minor compared to that of our friendly allies in Western Europe. Over 75 percent of Western Europe's requirements are now coming from the Middle East and by 1975, again according to the Paley Commission report, the imports into that area from the Middle East will reach 3.7 million barrels a day.

Unless we are prepared to sacrifice our allies and to risk shortages in our own country, we must adopt an oil import policy which will strengthen our position in all countries which are a source of oil supplies to the U. S. and to our allies and which will help assure availability of these supplies to us in peace or war.

U. S. Imports of Crude Oil and Refined Products, by Companies and Kinds of Oil, by Months, 1953-1954

(Source: Monthly Reports of Importing Companies to Texas Railroad Commission)

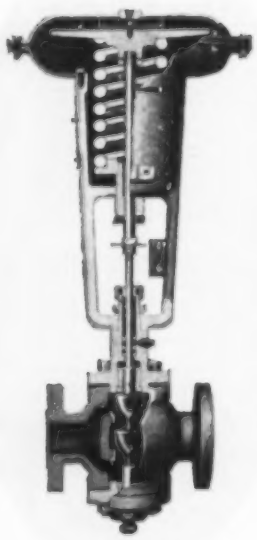
BARRELS DAILY

COMPANY, KIND OF OIL, AND SOURCE	1953											1954	
	February	March	April	May	June	July	August	September	October Estimate	November Estimate	December Estimate	January Estimate	February Estimate
Atlantic Refining Co., Crude Oil	55,800	51,100	55,700	62,400	67,100	53,500	73,400	62,100	64,800	64,800	64,800	64,800	64,800
Colombia, 20°							3,500		800	800	800	800	800
Venezuela, Total	41,600	47,600	43,000	55,700	54,500	40,700	63,300	55,800	56,000	56,000	56,000	56,000	56,000
38-44°	25,100	15,400	16,200	18,700	24,200	19,400	19,400	24,000	23,000	23,000	23,000	23,000	23,000
29-32°	16,500	25,700	20,000	27,100	23,400	11,400	34,000	21,700	26,400	26,400	26,400	26,400	26,400
14-16°		6,500	6,800	9,900	6,900	9,900	9,900	10,100	6,600	6,600	6,600	6,600	6,600
Kuwait, 31°	14,200	3,500	12,700	6,700	12,600	12,800	6,600	6,300	8,000	8,000	8,000	8,000	8,000
Asiatic Pet. Co. (See Shell Co's)													
Cities Service Co., Crude Oil	5,366	9,588	3,520	12,079	10,968	8,163	8,250	11,455	5,482	8,334	11,449	8,063	11,428
Venezuela 10.3-17.5°		9,588	3,520	9,787	5,008	4,856	8,250	11,455		5,000	5,805	4,838	5,357
Mexico 11-19.4°	5,366			2,292	5,960	3,307			5,482	3,334	5,644	3,225	6,071
Eastern States Pet Co. Total	15,000	11,492	14,480	22,700	20,000	18,700	17,350	13,300	21,500	14,000	14,000	14,000	14,000
Crude Oil, Mexico 9-19°	7,000	3,239	6,713	6,400	10,000	6,500	6,550	3,800	9,500	4,000	4,000	4,000	4,000
Products, Total, Mexico	8,000	8,253	7,767	16,300	10,000	12,200	10,800	9,500	12,000	10,000	10,000	10,000	10,000
Bunker C. Fuel Oil	4,000	1,903	4,545	10,000	6,700	9,000	4,400	6,400	8,000	6,000	6,000	6,000	6,000
Reduced Crude	4,000	6,350	3,222	6,300	3,300	3,200	6,400	3,100	4,000	4,000	4,000	4,000	4,000
Gulf Oil Corp., Total	96,000	148,000	99,000	115,000	140,000	113,000	110,000	128,000	105,000	111,000	102,000	121,000	94,000
Crude Oil, Total	82,000	138,000	89,000	97,000	128,000	111,000	90,000	117,000	88,000	97,000	88,000	107,000	79,000
Venezuela, Total	49,000	51,000	51,000	62,000	45,000	36,000	47,000	49,000	49,000	52,000	49,000	57,000	43,000
Above 25°	42,000	41,000	47,000	50,000	34,000	29,000	37,000	42,000	39,000	45,000	39,000	50,000	36,000
Below 25°	7,000	10,000	4,000	12,000	11,000	7,000	10,000	7,000	10,000	7,000	10,000	7,000	7,000
Kuwait, above 25°	33,000	87,000	38,000	35,000	83,000	75,000	43,000	68,000	62,000	56,000	65,000	54,000	67,000
Products, Total Venezuela	14,000	10,000	10,000	18,000	12,000	2,000	20,000	11,000	17,000	14,000	14,000	14,000	15,000
Residual	11,000	10,000	10,000	14,000	10,000		18,000	7,000	13,000	10,000	10,000	10,000	11,000
Gas Oil	3,000			4,000	2,000	2,000	2,000	4,000	4,000	4,000	4,000	4,000	4,000
Phillips Pet. Co., Crude, 43.2° Venezuela	7,100	6,198	6,730	6,489	6,772	6,505	6,468	6,793	6,452	6,667	6,452	6,452	7,143
Shell Companies, Products, Total	182,093	144,019	120,634	85,302	102,533	88,258	56,912	103,142	149,458	163,866	182,584	192,552	176,071
Asiatic Pet. Co., bonded fuel oil, Neth. Ant.	(7,800	(7,600)	(5,700)	(500)	(110,00)	(11,000)	(5,800)	(13,600)	(2,200)	(10,200)	(7,100)	(7,100)	(7,500)
Shell Caribbean Pet. Co., Resid. fuel oil, Venez., or Neth. Ant. sold to indep. distributors on East Coast	155,000	124,000	104,000	73,000	76,000	65,080	38,000	77,000	135,000	141,000	160,000	169,000	155,000
Shell Oil Corp., Products	19,293	12,419	10,934	11,802	15,533	12,258	13,012	12,542	12,258	12,666	15,484	16,452	13,571
Bunker C. Fuel Oil	14,686	3,774	267	3,194	1,300	3,613	4,335	1,233	3,226	3,333	6,452	6,452	3,571
Bunker C. Fuel Oil, Bonded			(2,767)	(3,323)	(5,433)	(3,419)		(2,376)	(2,258)	(2,333)	(2,258)	(2,258)	(2,500)
Finished Asphalt	4,607	8,645	7,900	5,285	8,800	5,226	8,677	7,800	6,774	7,000	6,774	6,774	7,500
Hvy. Marine Diesel, Bonded								(1,133)				(968)	
Sinclair Oil Corp., Crude Oil	57,000	72,290	64,700	90,200	66,300	70,000	66,102	55,977	66,000	66,000	66,000	66,000	66,000
Venezuela 30-35°	52,800	68,355	50,400	72,000	53,900	52,516	58,719	43,162	51,000	51,000	51,000	51,000	51,000
Mexico 25-29°	4,200												
Middle East Total		3,936	14,300	18,200	12,400	17,484	7,383	12,815	15,000	15,000	15,000	15,000	15,000
30-35°			8,500	12,300	8,600	8,323	3,486	12,815	10,000	10,000	10,000	10,000	10,000
36-41°			5,800	5,900	3,800	9,161	3,897		5,000	5,000	5,000	5,000	5,000
Socony-Vacuum Oil Co., Total	88,071	110,640	112,173	91,494	98,905	105,056	91,056	97,940	103,161	90,000	100,646	96,935	101,571
Crude Oil, Total	80,753	103,760	105,271	85,018	90,957	95,934	87,611	88,170	95,096	81,667	92,581	88,032	91,714
Venezuela, Total	24,839	27,233	23,880	30,550	26,058	35,960	27,851	35,704	*36,096	*29,667	*28,581	*32,032	*29,714
34-35° by Socony	24,839	27,233	23,880	30,550	22,096	32,048	27,851	31,702	*28,419	*29,667	*28,581	*32,032	*29,714
34-35° by General Pet.					3,959	3,912			7,677				
40-41° by General Pet.								4,002					
Colombia, Total	21,074	22,564	24,440	23,690	23,941	26,937	19,321	20,073	*23,000	*20,000	*24,000	*22,000	*24,000
20-21°		3,516		3,953		3,626			*3,000		*4,000		*4,000
32-33°	21,074	19,048	24,440	19,737	23,941	23,311	19,321	20,073	*20,000	*20,000	*20,000	*22,000	*20,000
Iraq, 35-36°	6,619	10,924	11,849						*4000,		*4,000		
Saudi Arabia, 35-36°			3,912	3,684	12,975	4,371							
Kuwait, 31-33°	28,221	34,684	32,807	27,094	24,114	28,666	36,732	32,393	*32,000	*32,000	*32,000	*34,000	*34,000
Qatar, 40-41° by Gen. Pet. Co.		8,355	8,383		3,869		3,707				*4,000		*4,000
Products: Fuel, Diesel	(7,318)	6,880	6,902	(6,476)	(7,948)	(9,122)	(3,445)	(9,770)	(8,065)	(8,333)	(8,065)	(8,903)	(9,857)
Standard Oil Co. of Calif., Crude Oil	89,797	111,217	123,345	115,033	124,533	97,416	114,801	130,430	102,900	102,900	102,900	102,900	102,900
Saudi Arabia, 35°	47,777	66,275	72,981	62,795	71,550	44,093	67,644	58,617	54,800	54,800	54,800	54,800	54,800
Sumatra, 35°	15,911	24,485	36,097	32,636	31,383	33,719	26,541	33,684	28,700	28,700	28,700	28,700	28,700
Venezuela, Total	26,109	20,457	14,267	19,602	21,600	19,604	16,733	32,227	18,200	18,200	18,200	18,200	18,200
16-54°	16,814	11,917	8,270		8,693	6,522	4,197	8,214	1,000	1,000	1,000	1,000	1,000
Asphalt Crude	9,295	8,540	5,997	19,602	12,907	13,082	12,536	24,013	17,200	17,200	17,200	17,200	17,200
Qatar, 39°							3,883	5,902	1,200	1,200	1,200	1,200	1,200
Standard Oil Co. (Ind.) Total	53,700	33,400	37,950	49,543	33,110	32,160	21,660	33,000	34,000	46,700	46,100	43,000	43,000
Asphalt Crude, Venez., 10-17°	10,700	9,300	6,950	15,470	9,810	16,750	18,740	19,910	10,000	10,000	8,900	10,000	10,000
Residual Fuel Oil, from suppliers who can supply foreign or domestic oil	43,000	24,100	31,000	34,073	23,300	15,410	2,920	13,090	24,000	36,700	36,100	33,000	33,000
Standard Oil Co. (N. J.) Total	229,000	263,000	226,000	247,000	181,000	188,000	187,000	221,000	252,000	252,000	252,000	283,000	283,000
Crude Oil, Total	103,000	91,000	77,000	85,000	83,000	76,000	94,000	88,000	79,000	79,000	79,000	81,000	81,000
Colombia, under 25°		20,900	19,000	25,000	24,000	14,000	20,000	19,000	23,000	23,000	23,000	17,000	17,000
Venezuela, Total		70,100	58,000	60,000	59,000	62,000	74,000	69,000	56,000	56,000	56,000	64,000	64,000
Under 25°		23,300	31,000		27,000	36,000	35,000	36,000	17,000	17,000	17,000	14,000	14,000
Over 25°		46,800	27,000		32,000	26,000	39,000	33,000	39,000	39,000	39,000	50,000	50,000
Residual, Caribbean, Total	126,000	172,000	149,000	162,000	98,000	112,000	93,000	133,000	173,000	173,000	173,000	202,000	202,000
Venezuela, Total		32,000	18,000		18,000			5,000	20,000	20,000	20,000	20,000	20,000
Under 25°		15,000	12,000		11,000			2,000	17,000	17,000	17,000	17,000	17,000
Over 25°		3,000	3,000					(1,000)					
—25° Bonded		(14,000)	(3,000)		(7,000)			(2,000)	(3,000)	(3,000)	(3,000)	(3,000)	(3,000)
Neth., Ant., Total		140,000	131,000		80,000	112,000	93,000	128,000	153,000	153,000	153,000	182,000	182,000
Under 25°		99,000	82,000		38,000	61,000	42,000	78,000	106,000	106,000	106,000	133,000	133,000
—25° Bonded		(40,000)	(49,000)		(38,000)	(51,000)	(50,000)	(50,000)	(46,000)	(46,000)	(46,000)	(48,000)	(48,000)
+25° Bonded		(1,000)			(4,000)		(1,000)		(1,000)	(1,000)	(1,000)	(1,000)	(1,000)
Sun Oil Co., Crude, Venezuela	15,189	4,025	7,678	15,187	9,002	11,373	7,313	18,778	17,903	16,000	7,258	14,193	8,036
26°				4,065	4,286	3,587		3,756	3,710				
30-32°	4,055		7,678	7,042		3,789			6,935	4,333		6,935	
32.4-35°	6,668						3,529						
35-36°								11,173	3,548	3,667	3,548	3,548	3,929
40-43.5°	4,466	4,025		4,080	4,716	3,997	3,793	3,849	3,710	8,000	3,710	3,710	4,107

* Continued on Page 218

Meet the modern valve for modern process control

the new Honeywell Series 800



Look at these features:

- **SMALL AIR CHAMBER . . .**
  minimum volume of dead air assures fast response to control air signals.
- **TIGHTLY SEALED DIAPHRAGM . . .**
  extra thick, molded-in gasket around bolt circle prevents air leaks; reinforced construction gives high flexibility, long life.
- **STAY-TIGHT STEM LOCK . . .**
  won't separate under most severe vibration.
- **STURDY, ATTRACTIVE YOKE . . .**
  no useless weight, but plenty of strength; stands roughest handling. Pads on both sides of yoke facilitate mounting of auxiliary equipment.
- **CHOICE OF BONNET DESIGN . . .**
  screwed or bolted.
- **PACKING . . .**
  graphite-impregnated asbestos or shredded Teflon.

New Solid V-ported Disc for high-velocity service

Now available with the Series 800 double seated line is this solid equal percentage disc. It's especially applicable to high velocities and high pressure drops; has better stability and resistance to erosion; minimizes noise. Rangeability up to 50 to 1.

Here's the new look—coupled with new performance standards—in diaphragm motor valves. The Honeywell Series 800 incorporates every feature of design that is demanded by the process control applications of today . . . and of tomorrow, too. In response . . . sensitivity . . . reproducibility . . . overall performance . . . the Series 800 valve is the ideal partner of advanced instrumentation. It's available in a full range of styles and sizes. Get complete technical data today, by writing for Bulletin 800.

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VALVE PRODUCTS
First in Controls

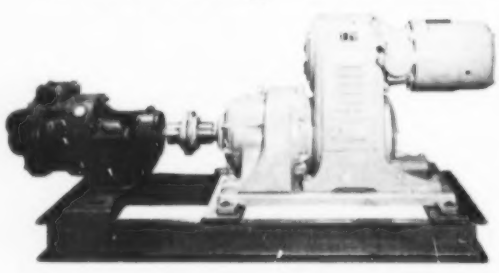
U. S. Imports of Crude Oil and Refined Products, by Companies and Kinds of Oil, by Months, 1953-1954

(Continued from Page 215)

COMPANY, KIND OF OIL, AND SOURCE	1953 February	March	April	May	June	July	August	September	October Estimate	November Estimate	December Estimate	1954 January Estimate	February Estimate
The Texas Co., Total	68,777	90,498	67,727	92,336	78,779	70,227	71,691	67,089	63,599	89,039	81,193	82,677	87,464
Crude Oil, Total	50,637	77,634	60,704	92,336	75,243	70,227	71,691	63,634	57,147	79,039	71,516	73,000	76,750
Venezuela, Total	10,747	21,997	11,001	25,528	15,665	24,960	30,072	22,348	14,415	22,500	29,516	21,452	28,393
29-31.5°	7,508	21,997	11,001	22,073	15,665	21,598	26,781	19,139	14,415	22,500	26,129	21,452	24,643
16°	3,239			3,455		3,362	3,291	3,209			3,387		3,750
Colombia, 32°										8,000		3,871	
Saudi Arabia, 35°	35,023	45,408	41,280	49,066	47,704	28,123	41,619	30,562	33,958	36,000	30,871	37,677	38,357
Sumatra, 35.5°	4,867	10,169	8,423	17,742	11,874	17,144		10,724	8,774	12,539	11,129	10,000	10,000
Residual, Caribbean	18,140	12,864	7,023		3,536			3,455	6,452	10,000	9,677	9,677	10,714
Total Above Companies, All Oils	962,893	1,055,467	939,637	1,004,768	939,902	862,358	831,903	949,004	1,015,255	1,047,306	1,062,282	1,099,572	1,090,413
Crude Oil, Total	564,342	677,351	607,311	682,612	681,685	623,368	644,926	666,047	625,280	626,407	628,856	629,440	633,771
Western Hemisphere	378,724	382,556	326,579	429,695	370,216	361,968	407,817	407,050	376,848	382,168	374,156	386,063	372,714
Venezuela	341,084	335,853	276,429	372,313	306,315	311,224	358,446	364,177	315,096	323,034	316,712	335,167	320,843
Colombia	21,074	43,464	43,440	48,690	47,941	40,937	42,821	39,073	46,800	51,800	47,800	43,671	41,800
Mexico	16,566	3,239	6,713	8,692	15,960	9,807	6,550	3,800	14,982	7,334	9,644	7,225	10,071
Middle East, Total	164,840	260,141	236,212	202,539	268,212	210,537	210,568	214,589	210,958	203,000	214,871	204,677	222,357
Iraq	5,619	10,924	11,849										
Kuwait	75,421	125,184	83,507	68,794	119,714	116,466	86,332	106,693	102,000	96,000	105,000	96,000	109,000
Qatar		8,355	8,383		3,569		7,590	5,902	1,200	1,200	5,200	1,200	5,200
Saudi Arabia	82,800	111,743	118,173	115,545	132,229	76,587	109,263	89,179	92,758	90,800	89,671	92,477	93,157
Middle East Unclassified		3,925	14,300	18,200	12,400	17,484	7,383	12,815	15,000	15,000	15,000	15,000	15,000
Far East (Sumatra)	20,778	34,654	44,520	50,378	43,257	50,863	26,541	44,408	37,474	41,239	39,829	38,700	38,700
Products, Total, Incl. Bonded	398,551	378,116	332,326	322,151	257,317	238,990	186,977	282,957	389,975	415,899	433,426	470,132	456,642
Venezuela-Neth. Ant.	390,551	369,863	324,559	305,851	247,317	226,790	176,177	273,457	377,975	405,899	423,426	460,132	446,642
Mexico	8,000	8,253	7,767	16,300	10,000	12,200	10,800	9,500	12,000	10,000	10,000	10,000	10,000
Less Bonded Fuel Oil	(15,118)	(62,600)	(60,467)	(10,299)	(73,381)	(74,541)	(60,245)	(79,879)	(62,523)	(70,866)	(67,423)	(71,229)	(71,857)
Products, Total, Excl. Bonded	383,433	315,516	271,859	311,852	183,936	164,449	126,732	203,078	327,452	345,033	366,003	398,903	384,785
Total, Above Companies, Crude Oil and Products, Less Bonded	947,775	992,867	879,170	994,464	865,621	787,817	771,558	869,125	952,732	971,440	994,859	1,028,343	1,018,556
Western Hemisphere	762,157	698,072	598,438	741,547	554,152	526,417	534,549	610,128	704,300	727,201	740,159	784,966	757,499
Venezuela-Neth. Ant.	716,517	643,116	540,518	667,865	480,251	463,473	474,378	557,755	630,518	658,067	672,715	724,070	695,628
Colombia	21,074	43,464	43,440	48,690	47,941	40,937	42,821	39,073	46,800	51,800	47,800	43,671	41,800
Mexico	24,566	11,492	14,480	24,992	25,960	22,007	17,350	13,300	26,982	17,334	19,644	17,225	20,071
Middle East	164,840	260,141	236,212	202,539	268,212	210,537	210,568	214,589	210,958	203,000	214,871	204,677	222,357
Far East (Sumatra)	20,778	34,654	44,520	50,378	43,257	50,863	26,541	44,408	37,474	41,239	39,829	38,700	38,700
U.S. Total Imports, Bureau of Mines, Aug. and Later Estimated	1,066,250	1,112,129	1,003,600	1,095,742	1,050,167	949,581	†926,000	†1,015,000	1,130,435	1,130,435	1,130,435		
Crude Oil	585,714	655,484	627,967	703,161	706,900	629,452	†673,000	†672,000	673,913	673,913	673,913		
Refined Products	480,536	456,645	375,633	392,581	343,267	320,129	†253,000	†343,000	456,522	456,522	456,522		
Excess over Data for Above Companies, or Imports of Other Companies, Total	118,475	119,262	124,430	101,278	184,546	161,764	154,342	145,875	177,703	158,995	135,576		
Crude Oil	21,372	21,867	20,656	20,549	25,215	6,084	28,074	5,953	48,633	47,506	45,057		
Refined Products	97,103	141,129	103,774	80,729	159,331	155,680	126,268	139,922	129,070	111,489	90,519		

* Company reported total crude only; total here distributed by WORLD OIL roughly in line with earlier trends, to make industry totals by sources possible.
† From American Petroleum Institute.

An Interesting VIKING Unit



Viking Pumps are leaders in service to the Oil Industry . . . tops in performance and dependability.

Shown here is a versatile unit of the heavy-duty style designed to handle thin or viscous liquids. Capacity ranges from 10 GPM to 1050 GPM with pressure to 200 lbs. This unit shows totally enclosed vari-drive with a wide speed range.

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Dollinger half soles are in stock right now . . . ready for immediate shipment in standard sizes and thickness. Prompt delivery on half soles fabricated to order.

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For inquiries regarding fabricated structural steel and plate steel, write to John Dollinger, Jr., Inc., Beaumont, Texas.

What Suppliers Are Doing . . .

M-H Sets Training Courses; Cited For Educational Aid

Schedules for industrial instruments maintenance and repair courses for the first half of 1954 at Minneapolis-Honeywell Regulator Company's Philadelphia training school have been announced by the company's Industrial division.

The division again listed a 14-weeks comprehensive class which it offered for the first time last year to include instruction in new devices. Other Honeywell customers' courses include two five-weeks sessions and several running up to three weeks. The 14-weeks comprehensive course will be held from February 15 to May 21. The two five-weeks courses will start January 4 and April 26. Shorter courses will start February 15, March 8, April 5, and June 7.

Drexel Institute of Technology recently recognized the assistance of the Philadelphia division of Honeywell in the education of more than 5000 Drexel students. The school awarded Honeywell's Brown Instruments division a citation for 31 years of partnership in a cooperative educational program. Honeywell has participated in the cooperative program since 1922. It was one of 35 firms cited.

Fritz W. Glitsch Holds Sales Meeting—

Attending Fritz W. Glitsch and Sons' recent annual sales conference in Dallas, Texas, were, left to right: bottom row—Robert W. Fowler, general sales manager, Dallas; S. G. Higginbotham, Los Angeles; B. A. Ross, Dallas; W. R. Greenman, Chicago; and Fritz W. Glitsch, Jr., secretary-treasurer, Dallas; top row—M. C. Glitsch, vice president, Dallas; Fritz W. Glitsch, Sr., founder, Dallas; Hans C. Glitsch, president, Dallas; K. E. Luger, Houston; R. L. Allen, Cleveland; G. W. Lindskog, New York; and J. J. Tunno, Tulsa.

Tube Turns Adds Branch Plant

A completely equipped branch flange plant has been established by Tube Turns, Inc., at 7120 Katy Highway in Houston to distribute Tube-Turn flanges for standard or special requirements. While the fittings are not stocked at the Houston plant, the new location does serve as a breakup point for carload shipments from the company's general offices at Louisville, Ky.

Insul-Mastic Adds Ellis as New Memphis Representative

M. H. Ellis Company of Memphis, Tenn., has signed a contract with Insul-Mastic Corporation of America to sell and apply Insul-Mastic coatings in the Memphis area. These coatings are the heavy, pressure applied, aphaltic type and will be used by the Ellis Company for corrosion preventive applications to industrial equipment. The company will also contract for the waterproofing of buildings.

Anderson and Halloran Get Babcock & Wilcox Appointments

In two appointments in the Tubular Products division of The Babcock & Wilcox Company, James S. Anderson has become general sales manager of the division, and Robert E. Halloran has assumed the newly created position of manager of mechanical sales.

Anderson has been with Babcock & Wilcox since 1941, when he was named a district salesman in the Tubular Products division's New York sales office. He was named assistant general sales manager of the division in December, 1948. In his new post he will headquarter at Beaver Falls, Pa., from where he will direct sales of the division's carbon, alloy and stainless steel tubular products.

Halloran has been associated with the company since 1941 except for a four-year period when he served in the armed forces. He returned from the service to the company in 1946, advancing to district salesman soon thereafter. In his new position he will also headquarter at Beaver Falls, to supervise the sales of the division's mechanical tubular products.

Nitrogen Division Opens Development Center—

A new organic research laboratory and development center was recently dedicated at Hopewell, Va., by Allied Chemical & Dye Corporation's Nitrogen Division. Located in a wooded section of Hopewell adjacent to the Division's ammonia laboratory, the center consists of two buildings which together provide some 40,000 square feet of working space. The research and engineering building houses the laboratories and the engineering staff, the smaller experimental building is for intermediate scale research. Construction of the $1 million development center was begun 11 months ago by Wigton-Abbott Corporation, which designed the building.

The Nitrogen Division's initial project in the organics field is the plant now under construction at Orange, Texas, scheduled for completion early next year.

Continuous Coking Units Made Available by Blaw-Knox

Blaw-Knox Company, Pittsburgh, through its Chemical Plants division, has made available to petroleum refiners the design and construction of continuous coking units, by arrangement with Standard Oil Development Company, owners of the fluid coking process.

The process is designed to convert heavy fuel oils or residues into more valuable materials. Any reduced crude or pitch that can be pumped may be charged to the unit. Much of the product is suitable for cracking to form motor fuel. The coke residue is pro-

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Before It Leaves the Factory

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The reason RIDGID Heavy-Duty Pipe Wrenches are known for the brutal punishment they can take is because of the toughness built into them, checked part by part and then hard work-tested when assembled . . . not just one wrench in 100 or 1000 but *every last one!* . . . Add the guaranteed repair-free housing, no-slip no-lock jaws, handy pipe scale, easy spinning adjustment nut and comfort-grip I-beam handle and you see why genuine RIDGID gives you the big value for your money. Buy them at your Supply House.

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duced in small particles, and is handled as a fluidized solid. Operation is continuous without periodic decoking.

Through its engineering offices in Tulsa, Chicago and Pittsburgh, the company also has made available its own decarbonizing process for petroleum feed stock preparation.

Rockwell Promotes Barnett To Valve Products Manager

Orville W. Barnett, manager of Nordstrom valve distributor sales for Rockwell Manufacturing Company, has been promoted to valve products manager. He succeeds Gilbert T. Bowman, former gas and Nordstrom valve products manager, who has been named to the newly created post of manager, Product department.

Barnett

Barnett joined Rockwell in 1934 and has done sales and service work in connection with Nordstrom valves ever since. Before joining Rockwell, he was employed by Michigan Consolidated Gas Company in work connected with conversions to natural gas.

Beckman Forms New Division to Handle Government Contracts

A new operating division to handle development, engineering and production work under selected government contracts, has been formed by Beckman Instruments, Inc.

General manager for the new Arga division will be J. L. Fahey, vice president and controller of Beckman. The division will be located at 220 Pasadena Avenue, South Pasadena, Calif.

The managerial and engineering staff will include Arnold Raines, Herbert Galman and Armand Adams, formerly in charge of Arga Instrument Company of Southampton, Pa. The eastern firm will continue in operation until completion of existing contracts, and then transfer to Southern California. All government work at Beckman will be carried out by the Arga division except for government purchases of standard Beckman products.

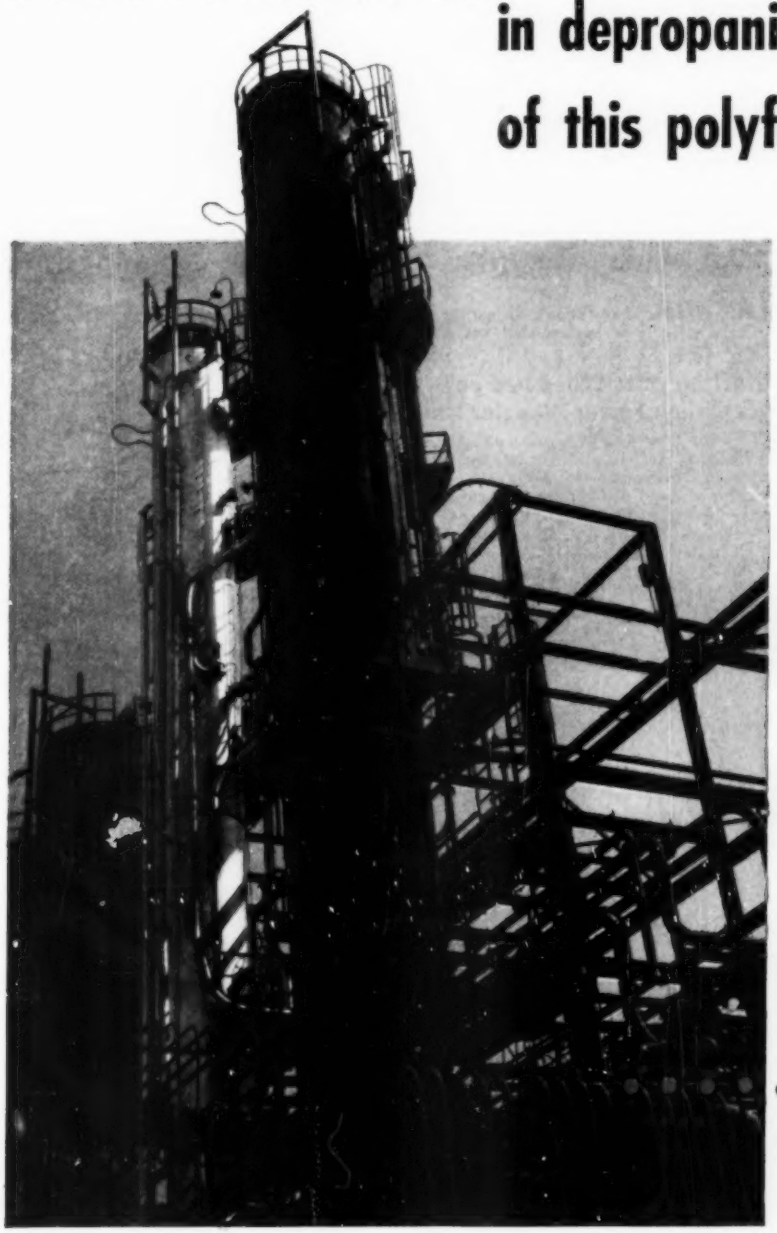
Three New Representatives Appointed by Annin Company

Ben McKalip Company, Tulsa, Trident Engineering Company, San Francisco, and Farnes and Martig Company, Portland-Seattle, have been appointed distributors for the Annin Company's line of Dormotor valves and other process equipment.

McKalip will handle the line in Oklahoma, the Texas Panhandle and sections of the Southwest. Ben McKalip, head of the company, has had many years experience in the sale and application of control equipment.

Trident Engineering, under the direction of Robert Kenyon and George Skopacek, both of whom are experienced in the application of control

Stainless Steel cuts tray plate cleaning in depropanizing tower of this polyform unit



HERE'S an example of the way Stainless Steel's corrosion resistance can stretch out the intervals between cleaning when used in refinery equipment.

Stainless Steel is now being used in the perforated tray plates in the depropanizing tower of the polyform unit at Gulf Oil Corporation's Port Arthur, Tex., refinery. The material formerly used for this purpose reacted with corrosive agents in the gas and the $^{3}/_{32}$" or $^{7}/_{64}$" perforations in the tray were plugged up after two to three months' use.

Then Stainless Steel was given the job. It has greater resistance to corrosion and, consequently, the intervals between cleanings are substantially longer.

Corrosion resistance is only one of the characteristics of Stainless that make it so suitable for refinery use. It is strong, its surface is dense and durable and it performs well in elevated temperature service. When you put all these advantages together, you can see why it is the most effective weapon against refinery down time.

For finest performance from Stainless equipment, always be sure that your equipment fabricator uses perfected, service-tested U·S·S Stainless Steel.

Depropanizing tower in the polyform unit at Gulf Oil Corporation's Port Arthur, Tex., plant. Stainless Steel, used in the perforated trays, has helped to lengthen the intervals between cleanings.

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH · TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
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valves and related equipment, will represent Annin in the Bay area and northern California.

Farnes and Martig will represent Annin in Oregon and the western counties of Washington. The company has been serving this territory for many years as sales and application engineers.

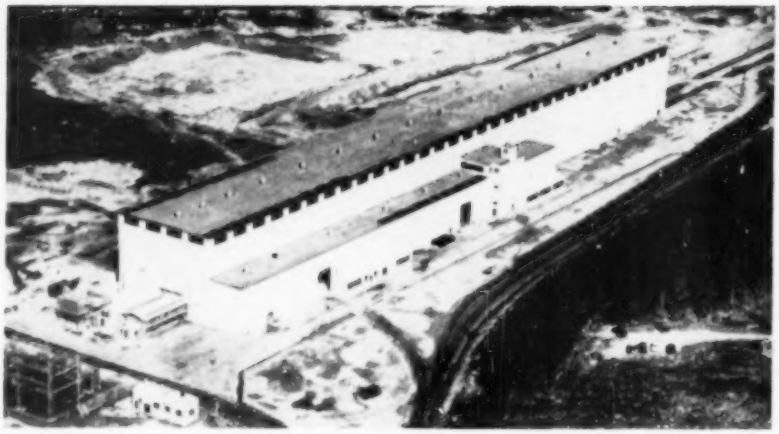
Scovill Manufacturing Moves To Larger New York Offices

Scovill Manufacturing Company of Waterbury, Conn., has moved its New York sales office from the Chrysler Building to the entire eighteenth floor of Chrysler Building East. The move was designed to provide larger headquarters for the expanding sales and service staffs serving this office's territory.

The New York office is district sales headquarters for the company's main plant products. District sales offices of two of the company's four other divisions are also centralized in the New York office.

A. O. Smith Division Assigns Schneller to Pacific Coast

A. R. Schneller has been appointed manager of welding sales for the Pacific Coast region by the Welding Products Division of A. O. Smith Corporation. He had previously been responsible for welding sales in Wisconsin. Earlier in 1953 Schneller won the "Oscar" of the Sales Executive Club of Chicago.



Foster Wheeler Corporation's $5 million fabricating plant, shown above shortly before it was completed, will start operating early next month.

Starting Date Scheduled For $5 Million Foster Wheeler Unit

Foster Wheeler Corporation has scheduled full scale operations at its new Mountaintop, Pa., plant to commence January 1. Limited operations at the plant, located nine miles south of Wilkes-Barre, were begun in mid-November and the interim period has been devoted to training new personnel.

Equipped with the most modern fabricating tools, the $5 million plant will turn out pressure vessels of varying proportions. Part of an $8 million expansion and re-tooling program started by Foster Wheeler three years ago, the new plant will also help to relieve heavy manufacturing schedules at the corporation's other plants in Carteret, N. J., Dansville, N. Y., and St. Catharines, Ont., Canada.

Among the plant's major tools is an 8000-ton hydraulic beam press weighing over three million pounds and said to have an effectiveness in bending steel plate—hot or cold—seldom before equalled. Largest of its type yet made, the press is capable of bending plate eight inches thick, and (in the case of lighter plate) 40 feet long into half-shells which, when welded together, will form pressure vessels of the unusual proportions required for the higher pressures demanded by various industries.

The plant stands on a 130-acre tract and is expected to employ 500 persons at full operation. Among the products to be fabricated are heat exchangers, sections of oil towers and pressure vessels weighing over 100 tons.

Du Pont Division Announces Appointment of Shaw and Bellah

Two appointments have been announced by the Petroleum Chemicals division of E. I. du Pont de Nemours and Company, Inc. John F. Shaw, formerly sales supervisor of the West Coast district office in Los Angeles, has been named assistant manager of the division's central district office, Chicago. In the other appointment, Jack S. Bellah, formerly chief process engineer for Refinery Engineering Company, has become refinery technologist in the division's technical section at Wilmington, Del.

Shaw started with Du Pont in April, 1947, as a sales service representative in Los Angeles and was promoted to sales supervisor of the West Coast district in 1952. In his new position he succeeds Barrett B. Russell, who has been transferred to Wilmington as technical assistant to the sales manager of the division.

Bellah's previous experience includes seven years with Socony-Vacuum Oil Company, a stint in the Army Aviation Ordnance Department, four years with Stanolind Oil and Gas Company, and three years at Refinery Engineering.

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Houston and Tulsa Changes Made by Edward Soph Company

The Edward Soph Company, manufacturer's representative handling cor-

Soph

Haynes

rosion resistant equipment and materials, has announced the addition of Richard E. "Dick" Haynes to its Tulsa staff. Formerly in the Materials division of the Petroleum Administration for Defense, he will be in charge of the company's Tulsa office. Haynes previously served in an engineering capacity with Shell Oil Company, Carter Oil Company, WPB, A. O. Smith Corporation and Edward Falck Company.

Because of the expansion of Soph activities in Texas, Edward J. "Bing" Soph, son of the company's president, has been moved to Houston. Soph is well known in the process industries.

Williamson Made Manager Of Cooper-Bessemer District

Appointment of R. G. Williamson as branch manager of its district office in Los Angeles has been announced by The Cooper-Bessemer Corporation, Mount Vernon, Ohio. Williamson replaces a branch manager who recently resigned.

Williamson

A graduate of the University of Southern California, Williamson has had extensive factory training in both engineering and operation of gas engines, diesel engines and compressors at Cooper-Bessemer's plants at Mount Vernon and Grove City, Pa.

Clark Equipment Revamps Southern Dealer Organization

Clark Equipment Company has revamped its dealer organization in the south to handle its newly-acquired Ross straddle carries and fork truck lines. Clark dealers affected by the plan are Industrial Truck Sales and Service Company, Greensboro, N. C.; Lukas Equipment Company, Columbia, S. C.; M-H Equipment Company, Birmingham, Ala.; Dempster Brothers, Inc., Knoxville, Tenn.; Whitmore Industrial Trucks, Tampa, and Equip Company Inc., Miami, Fla. Under the new plan Clark dealers will add Ross products to their regular sales and service activities. Clark acquired the Ross Carrier Company earlier this year, a company statement said.

Enjay Will Open New Office In Tulsa Under Hector Evans

Enjay Company, Inc., will open a new regional office in Tulsa January 1, 1954. Hector C. Evans will be in charge as manager, and Joseph E. McGinniss will be technical representative for the Southwest region.

Evans joined the Enjay Company in 1939 as a technical representative in the Synthetic Rubber division and, in 1951, became senior technical representative in the Eastern territory of the Paramins division. He has been associated with companies with which Enjay is affiliated since 1935.

McGinniss will come to the Southwest from an affiliated research organization which he joined in 1940.

Suppliers . . .

Babcock & Wilcox Executive Dies at 61 at New Rochelle

James H. King, vice president and director of The Babcock & Wilcox Company, New York, died last month at the New Rochelle, N. Y., Hospital. He was 61.

King joined Babcock & Wilcox in 1914 as a student engineer and was assigned to the Marine department in 1917. He rose to assistant manager of the Marine department in 1928 and was appointed manager of the department in 1931. He was elected a vice president of the company in 1945 and was named head of the Boiler division in January,

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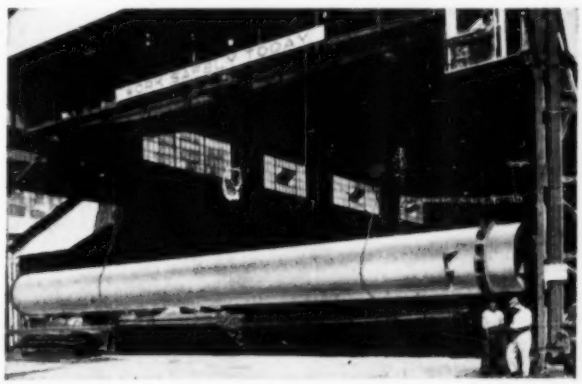

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1952. He was elected a director of the company in April, 1953. He also served as a director of the Diamond Power Specialty Company, and other firms.

Appleton Electric Appoints Vice President and Assistant

F. W. Wehrheim, a veteran of 33 years with Appleton Electric Company, has been elected vice president of the

Strong Wehrheim

company in charge of sales, and J. W. Strong, Denver sales representative, has been appointed his assistant.

Wehrheim joined Appleton in 1920 as a stock control clerk and has since served the company in various sales capacities. In his new post he succeeds E. A. Murray, resigned.

Strong, a Purdue University electrical engineering graduate, will make his headquarters at the company's home office in Chicago.

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Baldwin Hill Holds Open House—

Baldwin Hill Company held open house October 23 at its newly remodeled Temple, Texas, plant, where William H. Hull (center), president of the company, outlined the history and development of the insulation industry. Among the distributors present were W. H. Kause (left) and Granville Downs (right), of Industrial Insulations.

New Supply Company Formed At Shreveport by W. M. Haynes

W. M. (Sam) Haynes, formerly district manager of the Republic Supply Company, has announced the formation of a new supply company at Shreveport, La., to serve the oil and chemical industries in the Southwest. The new firm is to be known as Haynes Equipment Company.

Haynes

According to Haynes the company will specialize in refinery equipment, but will also handle a complete line of oil field, pipeline, chemical and industrial equipment and supplies.

For 17 years prior to World War II Haynes was chief maintenance and construction engineer for Continental Oil Company. He later served as engineer for Matheson Chemical Corporation. In 1943 he joined Republic Supply.

Van der Pyl Retires After 44-Year Service at Norton

Edward Van der Pyl, director of equipment engineering at Norton Company, Worcester, Mass., has retired after a career which began in 1909. During his career he has been responsible for 45 patents.

While at Norton, he served as resident engineer at the Hamilton, Ontario, plant and the French plant. Later he became assistant plants engineer and general development engineer prior to his latest position. Twice during his early Norton career, he left the company to engage in other activities.

Bierman Transferred to Tulsa as Edward Valves Sales Engineer

Edward Valves, Inc., East Chicago, Ind., has appointed H. W. Bierman as sales engineer for the territory comprising Oklahoma and parts of Missouri, Kansas, Arkansas and Texas.

Bierman

Bierman, formerly located at the Edward home office, will make his headquarters at Rockwell Manufacturing Company offices in Tulsa. Edward Valves, Inc., markets cast and forged steel valves for petroleum power plant, and other industrial and technological services.

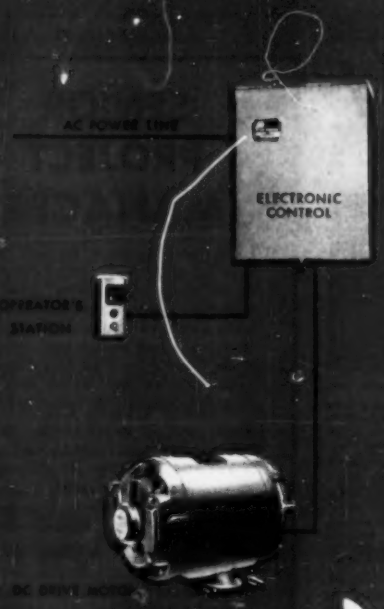
Beckman Instruments Appoints Manypenny Eastern Manager

John M. Manypenny, former sales manager with Harshaw Chemical Company's Scientific division, has been named Eastern district manager for Beckman Instruments, Inc. He will take charge of sales and service of Beckman products throughout the Eastern states, and will headquarter at the company's new branch plant in Mountainside, N. J.

Manypenny served as sales manager with Harshaw for the past six years. He previously spent nine years with the Bristol Company in industrial sales and market research.

Consolidated Chemical Moves Hickey to Manufacturing Post

C. M. Hickey, formerly general superintendent of plants in the Southern division of Consolidated Chemical Industries Inc., has been appointed man-



TYPE EV SPEEDRANGERS are electronically-controlled, Thyraton type, adjustable-speed power drives with a wide range of operating speeds and good speed regulation.

SIZES. ⅛ to 1½ HP with basic speed of 2400 RPM.

SPEED RANGE. Drive speeds are adjustable down to one sixth of the basic speed for continuous duty, 50°C.; down to one twentieth of the basic speed, intermittent duty.

HOW IT WORKS. Single phase AC power is converted by Thyraton type electronic rectifiers to supply a DC variable-speed drive motor. This DC drive motor is of the separately excited type, which inherently has good speed regulation.

STANDARD CHARACTERISTICS are constant torque rating over the full speed range . . . complete control from a compact operator's station . . . infinite steps of speed adjustment . . . smooth starting and good speed regulation.

OPTIONAL FEATURES are jogging, reversing, dynamic braking, wide or special speed ranges and special duty cycles.

New

electronic variable speed drives

TYPE GV SPEEDRANGERS are electronically-controlled, motor-generator type, adjustable-speed power drives with a wide range of operating speeds and good speed regulation.

SIZES. 2 to 10 HP with basic speeds of 2400, 1750 and 1150 RPM.

SPEED RANGE. Drive speeds are adustable down to one sixth of the basic speed for continuous duty, 50°C.; down to one tenth of basic speed intermittent duty.

HOW IT WORKS. Three or two phase AC power is converted by a motor-generator set and by tube type electronic rectifiers to supply a DC variable-speed drive motor. This DC drive motor is of the separately excited type, which inherently has good speed regulation.

OPERATION. The Type GV Speedrangers have the same standard characteristics and optional features as listed above for the Type EV Speedrangers.

MANY TYPES. The DC drive motor for both the Type EV and GV Speedrangers are available with Master Unibrakes, Fluid Drives and any of the five types of Master Gearmotors.

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"Related accounts wanted—valves, pipe fittings, pumps, packaged boilers, steam specialties, pressure or temperature instruments, power plant equipment, process piping products. Registered Mechanical Engineer organizing sales agency Southern California. Offer background of successful selling with excellent contacts oil companies, industrials." Box 171-W, c/o Petroleum Refiner, Houston, Texas.

POSITIONS WANTED

■ CHEMICAL ENGINEER, B.S., 28. Five years refinery engineering and operating experience. Desire engineering or supervisory position with a refinery, petrochemical or engineering organization. Box 177-R, c/o Petroleum Refiner, Houston, Texas.

■ SITUATION WANTED—CHEMICAL ENGINEER—Nine years in petroleum refinery process design, operations, and project handling. Good organizer and administrator; handle complete projects. Married, family. 172-R, c/o Petroleum Refiner, Houston, Texas.

■ Chemical Engineer, B.S.-M.S. and organic Chemistry M.S. Experience process design of petrochemical and gasoline plants and grease technologist. Will relocate South or Southwest. Box 174-R, c/o Petroleum Refiner, Houston, Texas.

HELP WANTED

■ GRADUATE ENGINEER, with research or operating experience in natural gas production and reservoir engineering, as an instructor and research assistant at Institute of Gas Technology, affiliate of Illinois Institute of Technology. Opportunity for graduate study and publication. Address Director, Institute of Gas Technology, Technology Center, Chicago 16, Illinois.

HELP WANTED

Process Engineer

ChE with 6-8 years experience in process design and development in chemical, petroleum or petro-chemical fields.

Should have a background in technical services and customer contact. Will work closely with operating division of internationally known engineering organization engaged in the design and development of oil refineries and chemical plants.

Excellent salary and opportunity for the right man to assume increasing responsibility. Benefits include executive insurance, unusually liberal pension plans and vacation policy. Traveling and moving expenses paid.

Please submit complete details of education, background, experience, past salaries, and initial salary requirements. Our personnel have been advised of this opening and complete privacy is assured.

Box 122, Room 1201
230 West 41 St., New York 36, N. Y.

HELP WANTED

SENIOR PROJECT MANAGER

Permanent position on our engineering staff for a mechanical or chemical engineering graduate with 8-10 years experience in petroleum refinery, petro-chemical or chemical plant design and development. Ours is an East Coast organization known the world over for accomplishments in these fields.

This position requires the capacity to assume immediate and complete responsibility for the coordination of the activities involved in this endeavor. There is considerable customer and vendor contact.

Our salary offer is high, and in addition we have a liberal pension plan, an accumulative vacation policy, executive insurance and many other employee benefits. We will assume the expense incurred by traveling and moving to this area.

Please write details of experience, education, salaries received and initial salary requirements. Complete privacy is guaranteed. Our personnel know of this opening.

Box 232, Room 1201
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Sales Engineer

To handle full line automatic control requirements in process industries. Chicago Division. Engineering degree required. Factory and field training provided. All replies kept strictly confidential. Write, giving age, marital status, education and full details of experience. Mason-Neilan Regulator Co., Tribune Tower, Chicago 11, Illinois.

OFFICE MANAGER

Man with experience in refinery payroll, credit, traffic and general accounting to head office personnel of new refining company located in Chicago area. Give complete details of experience, availability and salary desired in first letter. Box 173-R, c/o Petroleum Refiner, Houston, Texas.

■ **SENIOR PROCESS ENGINEER**—Heavy responsibility in process design and development for a ChE with eight to ten years' experience in petroleum or petrochemical fields. This is a permanent position with an East Coast organization known the world over for accomplishments in the design and development of oil refineries and chemical plants. The man selected must have the potential to supervise other senior process engineers. High salary. Traveling and moving expenses paid. Unusually liberal vacation, insurance and pension plans. Our staff knows of this opening. All replies held in strictest confidence. Please write details of experience, education, salaries received and initial salary requirements. Box 175-R, c/o Petroleum Refiner, Houston, Texas.

More Classified Ads on Next Page

Suppliers . . .

ager of manufacturing. Hickey has been with the company since 1924 and will continue to have his headquarters in Houston.

Allis-Chalmers Takes Over Operation of Buda Company

Allis-Chalmers Manufacturing Company has officially assumed operation of the Buda Company, 72-year-old Harvey, Ill., firm. It will be operated as "The Buda Company, a division of Allis-Chalmers."

Ralph K. Mangan, with Buda for 36 years and president since 1950, will be in charge of the division with the title of president and general manager. Buda will continue to manufacture, distribute and service all items in its regular line of products.

Stone & Webster Names New Publicity Representative

Alden E. Calkins has been named publicity and public relations representative of Stone & Webster, Inc., and affiliated companies. His office will be at 350 Fifth Avenue, New York.

Classified Ads (Continued)

HELP WANTED

PROJECT ENGINEERS

★ New York Engineering and Construction firm. Long established in the design and construction of process plants for the petroleum refining and chemical industries; has several openings in their project engineering dept. for graduate Chemical, Mechanical or Civil Engineers, with about 2-5 years experience in related plant operations, or design.

In reply please submit in detail educational background and experience.

Box 176-R

Petroleum Refiner, Houston, Texas.

CHEMICAL ENGINEER or equivalent, with oil refining background and knowledge of fluid catalytic cracking, for technical sales work with old, established chemical company in Mid-continent and Gulf Coast areas. Salary commensurate with experience. Submit resume of background and recent photo to Box 176-R, c/o Petroleum Refiner, Houston, Texas.

Armour Names Hoerner Director Of Chemical Purchases, Sales

John M. Hoerner has been appointed to the newly created post of Chemical division director of purchases and sales at Armour and Company. He will direct raw material purchases and the sale of chemical products, including fatty acids and derivatives and industrial oils.

Hoerner

Hoerner was previously associated with The Atlantic Refining Company, where he started 22 years ago as a chemist and advanced to chemical product sales manager. He is a graduate of Dickenson College, and received an M.S. degree at the University of Pennsylvania.

Company Changes

John R. Hamill, formerly manager of **Worthington Corporation's** Wilmington, Del., branch office, has been appointed manager of Worthington's Kansas City, Mo., district office. He succeeds **Paul J. Foley,** who has been appointed general sales manager for Worthington's Plainfield, N. J., Works' products . . . **Robert Lear & Son,** Louisville, Ky., has been named representative for the **Insul-Mastic Corporation of America** in that area . . . **Fred L. Hartley,** who has been with **Union Oil Company of California** for 15 years as manufacturing process supervisor in charge of process design, has been appointed manage or a new Commercial Development division established by Union in its Research and Process department. For the last three years, Hartley has been general superintendent of operations at Union's Los Angeles refinery . . . **The Foxboro Company** has opened a branch office at Amarillo, Texas. Assigned to the office as industrial engineer is **D. T. McElligott,** formerly with the Foxboro office in Dallas . . . **J. N. Holland,** Houston, has been appointed a sales engineer for the Meter and Valve division of **Rockwell Manufacturing Company.** He will cover most of East Texas, much of which territory was formerly handled by **Kenneth Rembert,** who will now devote more time in the Port Arthur-Beaumont-Lake Charles area.

Arthur B. Anderson Company, Minneapolis, Minn., has been named to represent **Hammel-Dahl Company** throughout Minnesota, North Dakota, South Dakota and part of Wisconsin . . . **Control Equipment, Inc.,** has been appointed exclusive distributors for **Enard Manufacturing Company** of Tulsa in the West Texas counties and the eastern section of New Mexico . . . **Hallikainen Instruments** has appointed the following manufacturer's representatives: for the territory composed of New York, Connecticutt, Pennsylvania, Delaware and New Jersey—**Louis M. Hachenberg,** Wood-Ridge, N. J.; for the territory composed of Illinois, Michigan, Iowa, Indiana and Wisconsin—**A & A Instrument Company,** Chicago . . . **Emjay Maintenance Engineers,** Rutherford, N. J., has opened a new branch in Philadelphia under **Charles A. Connell,** formerly president

Headquarters for PETROLEUM TESTING EQUIPMENT used by

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- PETROCHEMICAL PLANTS
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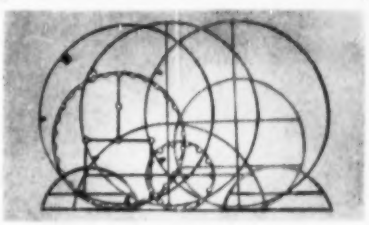

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Here is a dependable source for gaskets for heat exchangers. These gaskets can be made in any size or shape as needed—cut from solid metal, sheet-packing; also double jacket type.

Send specifications, blue prints or templates, for quotation and a prompt-delivery schedule for normal stocking orders.

CHICAGO-WILCOX MFG. CO.
7703 Avalon Avenue, Chicago 19, Ill.
Phone: SAginaw 1-1900

See Page 254 in Refinery Catalog

Suppliers . . .

of several subsidiaries of Lehigh Coal and Navigation Company.

George G. Zipf, formerly assistant superintendent of **The Babcock & Wilcox Company's** steel plant, has been appointed superintendent of the steel plant of the Tubular Products division. He has been with the company since 1942 . . . **G. (Gil) A. Armour** has been appointed field engineer in the Corpus Christi, Texas, area for **Durametallic Corporation.**

$250,000 Expansion Program

A $250,000 expansion of plant and manufacturing facilities has been announced for the Watson-Stillman division of H. K. Porter Company, Inc., Roselle, N. J.

Oil Well Opens New Houston Center—

A new oil field supply center to serve the Gulf Coast region has been opened in Houston by United States Steel Corporation's Oil Well Supply Division. The new facility will serve principally as "Oilwell's" Houston warehouse, supplanting a smaller unit which has been operating there for many years. It will also house a part of the area office personnel. The new building, shown above, is a two-unit structure with an over-all length of 352 feet.

With the opening of the new center, the division announced that its present three districts have been replaced with two districts. One district will headquarter at New Orleans, the other at San Antonio.

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Gary Succeeds Streander As Attapulgus Minerals President

Election of Wright W. Gary as president and chief executive officer of Attapulgus Minerals & Chemicals Corporation has been announced. He succeeds Louis R. Streander, who will retire as president January 1 after more than 40 years of service with the company. Streander will continue to serve Attapulgus as senior consultant.

For the past 11 years Gary has been president of Filtrol Corporation. During World War II he was national director of refining for the U. S. Petroleum Administration.

Geiger Succeeds Hockley As Davison Chemical President

Marlin G. Geiger, vice chairman of the board of directors of The Davison Chemical Corporation, has been elected president and chief executive officer of the corporation. He succeeds R. L. Hockley, resigned.

Geiger

Geiger joined Davison as executive vice president in 1947, was elected to the board of directors in that year, and in October, 1951, was elected vice chairman of the board. Before joining Davison, he was a vice president and director of Westvaco Chlorine Products Corporation.

R. L. Hockley had been with Davison since 1934.

New Michigan Sales Office Opened by Bridgeport Brass

Bridgeport Brass Company has opened a new sales office in the Federal Square Building in Grand Rapids, Mich., to handle the sales of all Bridgeport products.

The office will be under the direction of Thomas H. Williams, who was formerly connected with sales activities in the company's Indianapolis sales office. It will service the requirements of industry in Western and Southwestern Michigan.

Cooper-Bessemer Engineer Gets Top Examination Grade

The highest grade received in recent examinations for professional mechanical engineers was attained by John W. Holmes, an engineer for The Cooper-Bessemer Corporation, Mount Vernon, Ohio. The examinations, conducted by the Ohio State Board of Registration for Professional Engineers and Surveyors, were given to 712 applicants.

Associated with Cooper-Bessemer since 1945, Holmes presently is in the Applied Mechanics department, responsible for stress and vibration analyses.

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Engineered Sealing

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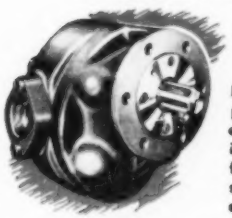
LIQUID HANDLING PUMPS

Virtually "any substance that will flow through a pipe," including petroleum products from naphthas to crudes and acid sludge, can be efficiently and economically handled in small or bulk quantities by Pumps available from this single source. There are deep and shallow well Centrifugal and Turbine Types, Rotating Plunger and Herringbone Pumps embracing a very broad range of types, sizes and constructions.

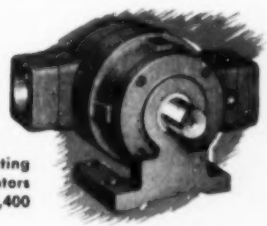
VACUUM PUMPS

High vacuum pumps for laboratory or high production service in research, vacuum distillation, refrigeration, dehydration, chemical processing, de-aerating, etc.



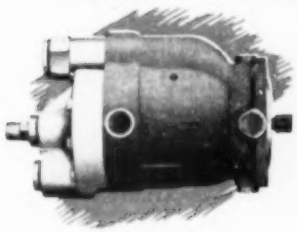
HYDRECO
GEAR TYPE PUMPS

Reversible and non-reversible. Gear type pumps in exclusive FOUR-BOLT design . . . capacities from .5 to 130 gpm and operating pressures to 1500 psi . . . flange or foot mounted . . . furnished with keyed shaft with spline shafts optional. Also dual and tandem models.



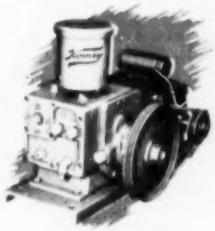
DUDCO
DUAL VANE TYPE PUMPS

DUDCO Pumps provide a broad range of sizes with capacities to 120 gpm and pressures to 2000 psi. Also available in dual units operating from a single drive. Hydraulic motors with starting torque outputs to 14,400 lb. in.



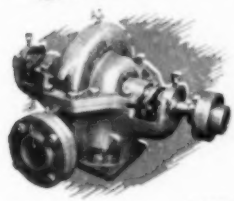
STRATOPOWER
PISTON TYPE PUMPS

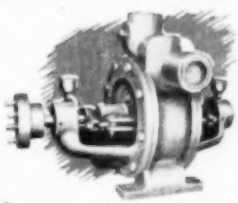
Axial reciprocating piston type . . . constant or variable delivery with capacities of .25 to 10 gpm at nominal speeds of 1500 rpm with maximum of 4500 rpm . . . working pressures to 3000 psi . . . direct engine and individual electric motor driven models.



KINNEY
VACUUM PUMPS

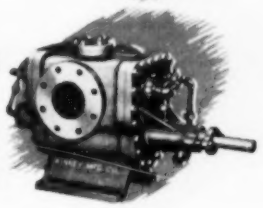
Single stage models to produce absolute pressure readings of 10 microns (.01 mm Hg.) . . . compound pumps producing readings of .2 microns (.0002 mm Hg.) or better. These Kinney High Vacuum Pumps are available in sizes for laboratory as well as high production use.





AURORA
CENTRIFUGAL & TURBINE PUMPS

Deep well, sump, drainage and condensation return units, household water systems. Industrial low and high pressure liquid handling pumps. Direct motor and countershaft driven horizontal and vertical models. Capacities 3 to 7500 gpm.



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A complete range of sizes in Rotating Plunger and Herringbone Gear Pumps to handle light or heavy liquids, from gasoline to asphalts. Available in plain or steam jacketed models.

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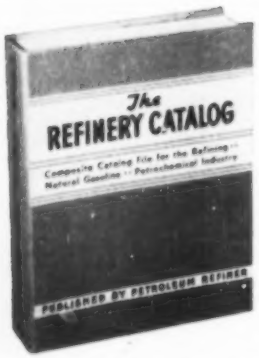
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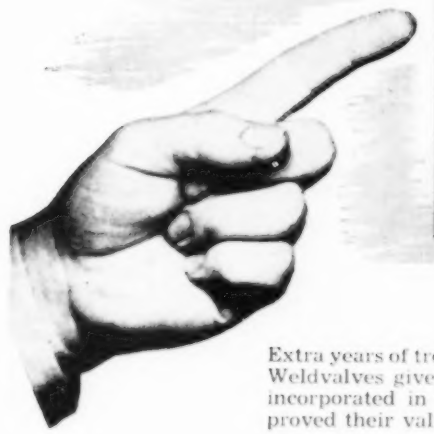

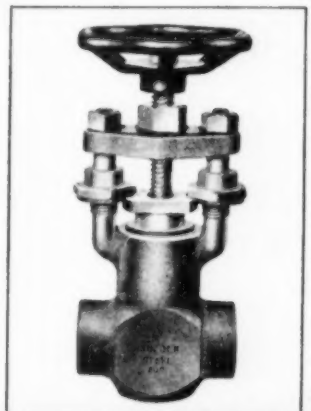

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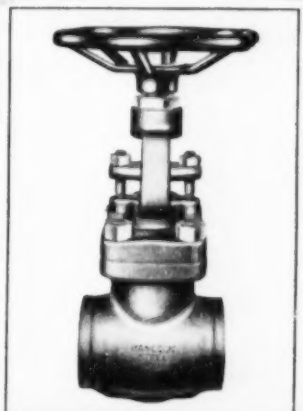

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ROOF VENTILATORS • UNIT HEATERS

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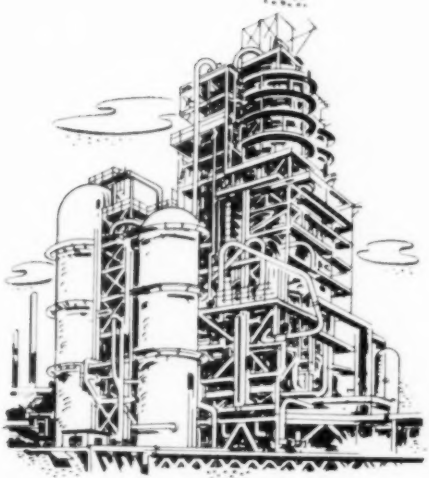

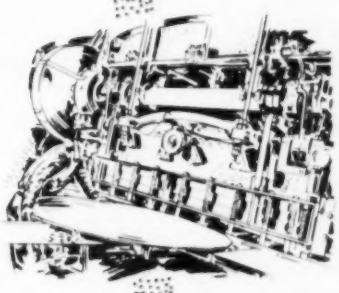

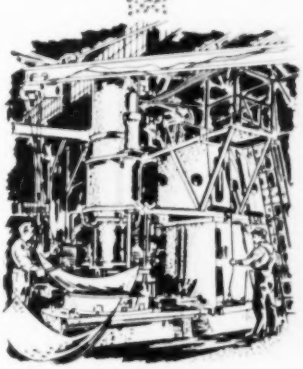

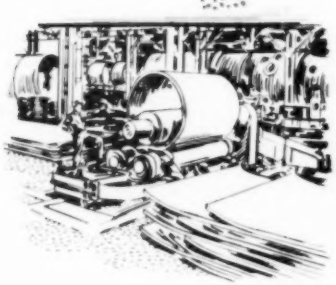

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Wyatt's

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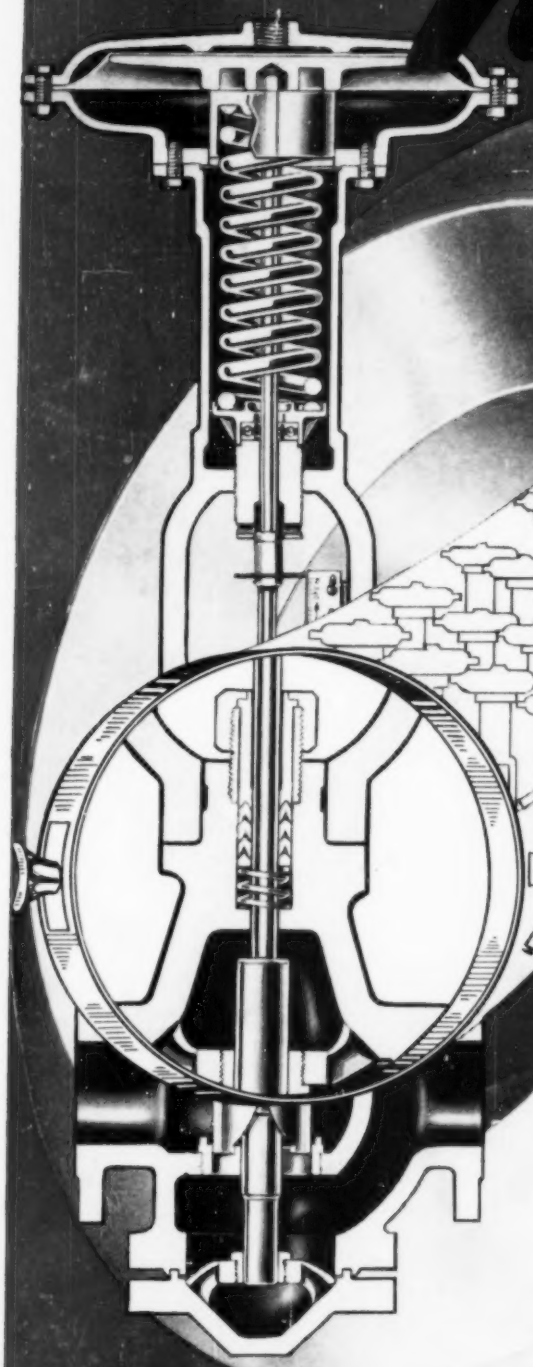
Teflon

V-RING PACKING



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Proved by many months of field service, Fisher Teflon V-Ring Packing features:

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- *Used on wide range of pressures without appreciable change in friction values.*
- *Elimination of maintenance and adjustment.*
- *No valve stem lubricators required.*
- *Chemically inert to all fluids up to 450° F.*

Fisher Teflon V-Ring Packing is now standard equipment on all Fisher Diaphragm Motor Valves.

Bulletin E-200 gives complete details.

*Teflon is the trade name of E. I. Du Pont de Nemours & Co.

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MARSHALLTOWN, IOWA